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IV.—ORATOR AND POET, ACTOR AND DRAMATIST.

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THINGS which during evolution become distinct were of course originally mingled: the process of evolution implies this. Already we have seen that in the triumphal reception of the conqueror, originally spontaneous and rude but in course of time becoming an established ceremonial elaborated into definite forms, there were germs of various arts and the professors of them. With the beginnings of dancing and music just described, were joined the beginnings of oratory, poetry, acting and the drama; here, for convenience, to be treated of separately. All of them manifestations of exalted emotion, at first miscellaneous and confused in their display, they only after many repetitions became regularized and parted out among different persons.

With the shouts of applause greeting David and Saul, came, from the mouths of some, proclamations of their great deeds; as, by Miriam, there had been proclamation of Yahveh's victory over the Egyptians. Such proclamations, at first brief and simple, admit of development into long and laudatory speeches; and, with utterance of these, begins the orator. Then among orators occasionally arises one more fluent and emotional than ordinary, whose oration, abounding in picturesque phrases and figures of speech, grows from time to time rhythmical, and hence the poet. The laudations, comparatively simple in presence of the living ruler, and afterward elaborated in the supposed presence of the apotheosized ruler, are, in the last case, sometimes accompanied by mimetic representations of his achievements. Among children, everywhere much given to dramatizing the doings of adults, we

may see that some one of a group, assuming the character of a personage heard about or read about, imitates his actions, especially of a destructive kind; and naturally therefore, in days when feelings were less restrained than now, adults fell into the same habit of representing the deeds of the hero they celebrated. The orator or poet joined with his speech or song the appropriate actions, or else these were simultaneously given by some other celebrant. And then, when further developments brought representations of more complex incidents, in which the victories of the hero and his companions over enemies were shown, the leading actor, having to direct the doings of subordinates, became a dramatist.

From this sketch of incipient stages based on established facts, but partly hypothetical, let us pass to the justifying evidence, supplied by uncivilized races and by early civilized races.

If we take first the usages of peoples among whom the musical faculty is not much developed we meet with the lauding official in his simplest form—the orator. Says Erskine of the Fijians, each tribe has its "orator, to make orations on occasions of ceremony, or to assist the priest and chief in exciting the courage of the people before going to battle": the encouragement being doubtless in large measure eulogy of the chief's past deeds and assertions of his coming prowess. So is it among the New Caledonians.

In Tanna "every village has its orators. In public harangues these men chant their speeches, and walk about in peripatetic fashion, from the circumference into the center of the marum [forum], laying off their sentences at the same time with the flourish of a club": [a dramatic accompaniment.]

And, according to Ellis, the Tahitians furnish like facts. Of their "orators of battle" he says—

"The principal object of these Rautis was, to animate the troops by recounting the deeds of their forefathers, the fame of their tribe or island, the martial powers of their favoring gods," etc.

The Negro races have commonly large endowments of musical faculty. Among them, as we have seen, laudatory orations assume a musical form; and, in doing so, necessarily become measured. For while spoken utterances may be, and usually are, irregular utterances which, being musical, include the element of time, are thereby in some degree regularized. On reading that among the Marutse, those who "screech out the king's praises" do so to a muffled accompaniment of their instruments," we must infer that, as the sounds of their instruments must have some rhythmical order, so too must their words. Similarly the Monbutto ballad-singers, whose function it is to glorify the king, must fall into versified expression of their eulogies. The "troop of

laureates or bards" kept at the Dahoman court, can not utter their praises in chorus without having these praises rhythmically arranged. So, too, in Ashanti and among the Mandingos, the laudations shouted before their chief men, having assumed the form of songs, must have verged into speech more measured than usual. Other uncivilized peoples show us the official orator and poet giving to his applause a musical form which must, by implication, be rhythmical. Atkinson says:—

"The Sultan ordered his poet to sing for us. The man obeyed, and chanted forth songs, describing the prowess and successful plundering expeditions of my host and his ancestors, which called forth thunders of applause from the tribe."

Among these African peoples, however, and the nomadic peoples of Asia just named, eulogies of the living ruler, whether or not with rhythmical words and musical utterance, are but little, or not at all, accompanied by eulogies of the apotheosized ruler, having a kindred form but with priests in place of courtiers. Why is this? There appear to be two reasons, of which perhaps one is primary and the other secondary. We have seen that among the Negro peoples in general, ideas about life after death, where they exist, are undeveloped. The notion is that the double of the dead man does not long remain extant: when there are no longer any dreams about him he is supposed to have perished finally. Consequently, propitiation of his ghost does not grow into a cult, as where there has arisen the notion that he is immortal. And, then, possibly because of this, African kingdoms are but temporary. It is remarked that from time to time there arises some powerful chief who conquers and consolidates neighboring tribes and so forms a kingdom; but that after a generation or two this ordinarily dissolves again. We have seen how powerful an aid to consolidation and permanence is the supposed supernatural power of a deceased ruler; and hence it appears not improbable that the lack of this belief in an immortal god, and consequent lack of the established worship of one, is a chief cause of the transitory nature of the African monarchies.

This supposition harmonizes with the facts presented to us by ancient civilized societies, in which, along with praises of the living ruler, there went more elaborate praises of the dead and deified ruler.

Egypt furnishes instances of poetic laudations of both. Preceding a eulogy of Seti I, it is written:—

"The priests, the great ones, and the most distinguished men of South and North Egypt have arrived to praise the divine benefactor on his return from the land of Ruthen." Then follows a song "in praise of the king and in glorification of his fame."

So too Rameses II is glorified in "the heroic poem of the priest Pentaur." In the eighteenth dynasty we see the two functions united.

"An unknown poet, out of the number of the holy fathers, felt himself inspired to sing in measured words the glory of the king [Thutmes III], and the might and grandeur of the god Amon."

And then we have the acts, wholly priestly, of—

"the nobleman who bore the dignity of 'prophet of the Pyramid of Pharaoh.' This officer's duty was to praise the memory of the deceased king, and to devote the god-like image of the sovereign to enduring remembrance."

Still better and more abundant evidence is furnished by accounts of the early Greeks. The incipient poet, as eulogizer of the god, is priestly in his character and at first is an official priest. Concerning the Greeks of rude times Muir writes—"Hence, in their traditions, the character of poet is usually found to combine those of musician, priest, prophet, and sage;" and he adds that—

The mythical poet Olen "ranks as the earliest and most illustrious priest and poet of the Delian Apollo . . . Bœo, a celebrated priestess of that sanctuary [the Delphic], pronounces him . . . to be, not only the most antient of Apollo's prophets, but of all poets."

We are told by Mahaffy that "the poems attributed to these men [poets prior to Homer] . . . were all strictly religious."

"The hexameter verse was commonly attributed to the Delphic priests, who were said to have invented and used it in oracles. In other words, it was early used in religious poetry . . . There is no doubt that the priests did compose such works [long poems] for the purpose of teaching the attributes and adventures of the gods. Thus epic poetry [was at first] purely religious . . . Homer and Hesiod represent the *close* of a long epoch."

And that their poetry arose by differentiation from sacred poetry, is implied in his further remark that in Homer's time, "the wars and adventures, and passions of men, had become the center of interest among the poets." This partially secularized poetry at a later date became further secularized, while it became further differentiated from music. The hymn of the primitive priest-poet was uttered to the accompaniment of his four-stringed lyre, in a voice more sonorous than ordinary speech—not in song, as we understand it, but in recitative; and, as Dr. Monro argues, a vague recitative—a recitative akin to the intoning of the liturgy by our own priests, and to the exalted utterance spontaneously fallen into under religious excitement.* But in course of time, this quasi-

* In his learned work, *The Modes of Ancient Greek Music*, he writes:—"Several indications combine to make it probable that singing and speaking were not so widely separated from each other in Greek as in the modern languages with which we are most familiar." (p. 113) . . .

. . . "For if the language even in its colloquial form had qualities of rhythm and intonation which gave it this peculiar half-musical character, so that singing and speaking were

musical utterance of hexameters was dropped by a certain derived secular class, the Rhapsodists. These, who recited at courts "the books [of Homer] separately, some one, some the other, at the feasts or public solemnities of the Greek cities," and who themselves sometimes composed "dedicatory prologues or epilogues in honor of the deities with whose festivals such public performances were connected," and became in so far themselves poets, were distinguished from the early poets by their non-musical speech.

"While the latter sang, solely or chiefly, his own compositions to the accompaniment of his lyre, the rhapsodist, bearing a laurel branch or wand as his badge of office, rehearsed, without musical accompaniment, the poems of others:" [sometimes, as above said, joined with his own].

Thus there simultaneously arose a class of secular poets and a divergence of poetry from song.

A parallel genesis occurred among the Romans. Though its sequences were broken, its beginning was the same. Says Grimm—

. . . "Poetry borders so closely on divination, the Roman vates is alike songster and soothsayer, and soothsaying was certainly a priestly function."

Congruous with this is the statement that—

"Roman religion was a ceremonial for the priests, not for the people; and its poetry was merely formulæ in verse, and soared no higher than the semi-barbarous ejaculations of the Salian priests or the Arvolian brotherhood."

The more elaborated forms of religious ceremony appear to have been imported from subjugated countries—the sacred games from Etruria, and other observances from Greece. Hence the Romans being the conquerors, it seems to have resulted that the arts, and among others the art of poetry, brought with them by the captives, were for a long period lightly thought of by their captors. Having no commission from the gods, the professors of it were treated with contempt and their function entirely secularized. So that, as Mommsen writes:—

"The poet or, as he was at this time called, the "writer," the actor and the composer, not only belonged still, as formerly, to the despised class of laborers for hire, but were still, as formerly, placed in the most marked way under the ban of public opinion, and subjected to police maltreatment."

With like implications in a later chapter he adds:—

"None of those who in this age appeared as poets before the public, as we have already said, can be shown to have been noble, and not only so, but none can be shown to have been natives of Latium proper."

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more closely akin than they ever are in our experience, we may expect to find that music was influenced in some measure by this state of things." (p. 119).

Thus it is clear that the primitive priest-poet of the Greeks was simply an emotionally-excited orator, whose speech diverged from the common speech by becoming more measured and more intoned.

More coherent evidence concerning the differentiation of the poet from the priest is hardly to be expected where, instead of a continuous evolution of one society, we have an agglomeration of societies, in which the conquering society from the beginning incorporated other ideas and usages with its own.

When, from Southern Europe of early days, we turn to Northern Europe, we meet, in Scandinavia, with evidence of a connection between the primitive poet and the medicine-man. Speaking of the "diviners, both male and female, honored with the name of prophets," who were believed to have power to force the ghosts of the "dead to tell them what would happen," Mallet says that "poetry was often employed for the like absurd purposes:" these same skalds or bards were supposed to achieve this end "by force of certain songs which they knew how to compose." At the same time that these poets and musicians of the ancient northern nations invoked the spirits of the departed in verses which most likely lauded them, they "were considered as necessary appendages to royalty, and even the inferior chieftains had their poets." The Celts had kindred functionaries, whose actions were evidently similar to those of the Greek priest-poets. Says Pelloutier, basing his statement on Strabo, Lucan, and others:—

"Les Bardes, qui faisoient [des] Hymnes, etoient Poëtes et Musiciens; ils composoient les paroles, et l'air sur lequel on les chantoit."

The use of the word "hymnes" apparently implying that their songs had something of a sacred character. That the connection between poet and priest survived, or was re-established, after paganism had been replaced by Christianity, there is good evidence. In the words of Mills—

"Every page of early European history attests the sacred consideration of the minstrel;" his peculiar dress "was fashioned like a sacerdotal robe."

And Fauriel asserts that—

"Almost all the most celebrated troubadours died in the cloister and under the monk's habit."

But it seems a probable inference that after Christianity had subjugated paganism, the priest-poet of the pagans, who originally lauded now the living chief and now the deified chief, gradually ceased to have the latter function and became eventually the ruler's laureate. We read that—

"A joculator, or bard, was an officer belonging to the court of William the Conqueror."

"A poet seems to have been a stated officer in the royal retinue when the king went to war."

And among ourselves such official laureateship still survives, or is but just dying.

While the eulogizer of the visible ruler thus became a court-functionary, the eulogizers of the invisible ruler—no longer an

indigenous deity, but one of foreign origin—came to be his priests; and in that capacity praised him, sometimes in poetical, sometimes in oratorical, form. Throughout Christendom from early times down to ours, religious services have emphasized in various proportions the different attributes of the deity—now chiefly his anger and revenge, now chiefly his goodness, love, and mercy; but they have united in ceaseless exaltation of his power; and the varieties of oral admiration, of invocation, of devotion, have been partly in prose and partly in verse. All along the Church-service has had for its subject-matter this or that part of the divine story, and all along it has embodied its ideas and feelings in a semi-rhythmical liturgy, in hymns, in the orations which we call sermons: each of them having in one way or other the laudatory character. So that the Christian priest has throughout stood in substantially the same relation to the being worshiped, as did the pagan priest, and has perpetually used kindred vehicles of expression.

While the Christian priest has been officially one who repeated the laudations already elaborated and established, he has also been to a considerable extent an originator, alike of orations and poems. Limiting ourselves to our own country, and passing over the ancient bards, such as Taliesin and Merlin, whose verses were in praise of living and dead pagan heroes, and coming to the poets of the new religion, we see that the first of them Cædmon, a convert who became inmate of a monastery, rendered in metrical form the story of creation and sundry other sacred stories—a variously elaborated eulogy of the deity. The next poet named is Aldhelm, a monk. The clerical Bede again, known mainly by other achievements, was a poet, too; as was likewise bishop Cynewulf. For a long time after, the men mentioned as writers of verse were ecclesiastics; as was Henry of Huntingdon, a prior; Geraldus Cambrensis, archdeacon; Layamon, priest; and Nicholas of Guildford. Not until Edward III's reign do we find mention of a secular song-writer—Minot; and then we come to our first great poet, Chaucer, who, whether or not "of Cambridge, clerk," as is suspected, became court-poet and occupied himself mainly with secular poetry. After this the differentiation of the secular verse-writer from the sacred verse-writer became more marked, as we see in the case of Gower; but still, while the subject-matter of the poems became more secularized, as with Langland and with Barbour, the ecclesiastical connection remained dominant. Lydgate was priest, orator and poet; Occleve, poet and civil servant; William of Massington, proctor and poet; Juliana Berners, prioress and secular poetess; Henryson, schoolmaster and poet; Skelton, priest and poet laureate; Dunbar, prior and secular poet; Douglas, rector and court-poet; Barclay, priest and poet; Hawes,

priest and poet; and so on. It should be added that one of the functions of the clergyman has been the writing of laudatory hymns—hymns composed now by ordained ecclesiastics, now by dissenting ministers. These facts, joined with facts of recent times, make it clear that as in pagan societies, so in Christian societies, the priest-poet, appointed eulogizer of the deity he serves, is the first poet; and that the poets we distinguish as secular have gradually arisen by differentiation from him.

Along with the divergence of secular poets from sacred poets there have arisen divergences within the assemblage of secular poets themselves. There have come the mainly epic, as Milton; the didactic, as Pope; the satiric, as Butler; the descriptive, as Wordsworth; the comic, as Hood.

From those official praisers of the hero or god whose laudations take the form of speech, non-rhythmical or rhythmical, we pass to those whose laudations take the form of mimetic actions —who express the triumphs of the deified ruler by imitations of his deeds. United as the two originally were, they diverge and develop along their respective lines.

Existing savages yield illustrations of the primitive union of vocal laudation and mimetic laudation. Concerning the Point Barrow Eskimo we read:—

"The most important festivals are apparently semi-religious in character and partake strongly of the nature of dramatic representations. . . . All festivals are accompanied by singing, drumming, and dancing."

More detailed evidence is supplied by an official account of the Navajo Indians, from which here are relevant passages:—

"Hasjelti Dailjis, in the Navajo tongue, signifies the dance of Hasjelti, who is the chief or rather the most important and conspicuous of the gods. The word dance does not well designate the ceremonies, as they are in general more histrionic than saltatory. . . . The personation of the various gods and their attendants and the acted drama of their mythical adventures and displayed powers exhibit features of peculiar interest. . . . Yet, from what is known of isolated and fragmentary parts of the dramatized myths, it is to be inferred that every one of the strictly regulated and prescribed actions has or has had a special significance, and it is obvious that they are all maintained with strict religious scrupulosity."

And it is added that each of these observances "clearly offers a bribe or proposes the terms of a bargain to the divinities."

Noting next the evidence furnished by Ancient India, we are led to infer that there, as elsewhere, the triumphal reception of a conqueror was the observance from which sprang the dramatic art, along with the arts we have thus far contemplated. Weber writes—

"Next to the epic, as the second phase in the development of Sanskrit poetry, comes the Drama. The name for it is *Nâtaka*, and the player is

styled *Nata*, literally 'dancer.' Etymology thus points to the fact that the drama has developed out of dancing, which was probably accompanied, at first with music and song only, but in course of time also with pantomimic representations, processions, and dialogue."

And though himself offering another interpretation, he quotes Lassen to the effect that—

"The Indian drama, after having acquitted itself brilliantly in the most varied fields—notably too as a drama of civil life—finally reverted in its closing phases to essentially the same class of subjects with which it had started—to representations from the story of the gods."

Greek history yields various facts of like meaning. In Sparta—

"The singing chorus danced around it ['the sacrifice . . . burning on the altar'] in the customary ring; while others represented the subject of the song by mimic gesture."

That the drama had a religious origin is shown by the fact that it continued always to have a religious character. Says Moulton—"the performance of every drama was regarded by the ancients as an act of worship to Dionysus." And to like effect is the statement of Mahaffy that—"the old Greek went to the theater to honor and serve his god." The dramatic element of religious ceremonies was at first mingled with the other elements, as is implied by Grote, who speaks of the importance of the united religious celebrants—

"in the 'ancient' world, and especially in the earlier periods of its career—the bards and rhapsodes for the epic, the singers for the lyric, the actors and singers jointly with the dancers for the chorus and drama. The lyric and dramatic poets taught with their own lips the delivery of their compositions."

The process of differentiation by which the drama arose is well shown by the following extracts from Moulton:—

"Only one of these Ballad-Dances was destined to develop into drama. This was the Dithyramb, the dance used in the festival worship of the god Dionysus.

". . . the 'mysteries' of ancient religion were mystic dramas in which the divine story was conveyed."

"The chorus started from the altar in the center of the orchestra, and their evolutions took them to the right. This would constitute a Strophe, whereupon (as the word 'Strophe' implies) they turned round and in the Antistrophe worked their way back to the altar again."

In lyric tragedy "the Chorus appears as Satyrs in honor of Dionysus, to whose glory the legend is a tribute; they maintain throughout the combination of chant, music, and dance."

"The work of Thespis was to introduce an 'actor,' separate altogether from the chorus."

That along with differentiation of the drama from other social products there went differentiation of the dramatist and the actor from other persons and from one another, may fairly be inferred, however little able we may be to trace the process. Already, by

the above extract from Grote, we are shown that a leading actor gave oral directions to subordinate actors; and in doing this he assumed to some extent the character of dramatist. Before the rise of a written literature no greater distinction could be made; but after written literature arose, the dramatist proper became possible. Still, it is to be observed that in the productions of the great dramatic writers of Greece, the original relations continued to be shown. As Moulton remarks:—

"Tragedy never ceased to be a solemn religious and national festival, celebrated in a building which was regarded as the temple of Dionysus, whose altar was the most prominent object in the orchestra."

And the subject-matter continued in late days as in early days to be, in chief measure, the doings of the gods. An illustration is furnished by Mahaffy, who says:—

"We hear in the days of the Ptolemies about 250 B. C., of a regular symphony at a Delphic feast, in which the contest of Apollo and the Python was represented in five movements with the aid of flutes (or rather clarinettes, αὐλοί), harps, and fifes without singing or libretto."

Clearly this incident, which while mainly showing the development of instrumental music, shows also the kind of theme chosen. But when we come to the comedies of Aristophanes we see a complete secularization.

Partly because, as pointed out above in following the genesis of the poet, so much of Roman civilization was not indigenous but foreign, and partly because Roman life, entirely militant, led to a contempt for all non-militant occupations (as happens everywhere); the rise of the dramatist in Rome is indefinite. Still we find indications akin to the foregoing. Duruy, in agreement with Guhl and Koner, writes that—

In 364 during a pestilence the Romans applied to the Etruscans who "replied that the gods would be satisfied if they were honored by scenic games, and, that the Romans might be able to celebrate these games, they sent them at the same time actors, who executed religious dances to the sound of the flute . . . the pestilence then ended."

And he goes on to say that—

"Young Romans learnt the dances introduced from Etruria, and marked the rhythm of them by songs, often improvised, which ended by being accompanied with action. Roman comedy was discovered."

In Rome as in Greece an idea of sacredness long attached to the drama. "'Varo,' says St. Augustine, 'ranks theatrical things with things divine.'" This conception of sacredness, however, was congruous with their conceptions of the gods, and widely different from sacredness as understood by us.

"The subjects of the pantomime were taken from the myths of gods and heroes, the actor having to represent male and female characters by turns, while a choir, accompanied by flute-players, sang the corresponding canticum."

"Sometimes mythological scenes were performed in the arena with cruel accuracy. Condemned criminals had to mount the pyre like Hercules, or to give their hand to the flames like Mucius Scævola, or to be crucified like Laureolus the robber; others were torn by bears, in imitation of the fate of Orpheus."

Having usually been an alien and possessing no odor of sanctity derived from his traditional religious function,—

The actor "was ranked with slaves and barbarians . . . he generally was a slave or freedman, or a native of some country where his profession was more esteemed, such as the Greek colonies and the East generally."

Little as one might have expected it, we find that the pagan genesis of the drama was paralleled by the Christian regenesis of it in mediæval Europe. It commenced, as in India, Greece, and Rome, with representations of sacred subjects by priestly actors. Incidents in the life of the god were dramatically repeated in edifices devoted to his worship.

"The circumstance that the ritual was carried on in Latin naturally led to its being supplemented on particular occasions with sacred scenes or lessons acted to the ignorant."

"Thus the *raison d'être* of the mysteries and miracle plays was to act stories from Scripture or the lives of Saints, or embodying central doctrines such as the incarnation, for the benefit of a populace unable to read for themselves."

But there are confused evidences and conflicting opinions respecting dramatic representations in early Christian days—secular and sacred origins appearing to be mingled. We read that "sometimes when a sufficient number of clerical actors were not to be procured, the churchwardens . . . caused the plays to be acted by secular players." And in the same work we also read that "complaint [to Richard II] is made against the secular actors, because they took upon themselves to act plays composed from scripture history, to the great prejudice of the clergy." But in another passage the writer, Strutt, says that these acted mysteries "differed greatly from the secular plays and interludes which were acted by strolling companies, composed of minstrels, jugglers, tumblers, dancers, bourdours or jesters . . . these pastimes are of higher antiquity than the ecclesiastical plays." Not improbably such companies may have survived from pagan times, in which their representations formed part of the pagan worship: losing their original meanings, as did the songs of the minstrels. This view seems congruous with the opinion that the secular drama did not arise by direct descent from the mystery-plays, but that, influenced by the familiarity of its writers both with them and with the popular exhibitions, it took its definite form mainly by suggestion of the classic drama: a supposition favored by the fact that in various Elizabethan plays a chorus is introduced. Be this

as it may, however, the general implication remains the same. There arose in Christendom, as in Greece, a sacred drama performed by priests and representing incidents in the sacred story; and if our secular drama did not directly descend from this Christian religious drama, then it indirectly descended from the original pagan religious drama.

Along with the rise of the secular drama have arisen minor differentiations. The separation between actor and dramatist, though still not complete, has become greater; most dramatic authors are not actors. And then the dramatic authors are now distinguished into those known as producers chiefly of tragedy, comedy, melodrama, farce, burlesque.

We meet here with no exception to the general law that segregation and consolidation are parts of the evolutionary process. Beginning with Greece we trace the tendency even among the poets. Curtius remarks that "poetry like the other arts was first cultivated in circles limited after the fashion of guilds." And the religious character of these guilds is shown by the further statement that "schools of poets came to form themselves which were . . . intimately connected with the sanctuary."

Naturally the process readily took place with those occupied in combined representations; for they, as a matter of necessity, existed as companies. But there early arose more definite unions among them. Mahaffy says, concerning the Greeks, that—

> "Inscriptions reveal to us the existence of guilds of professionals who went about Greece to these local feasts, and performed for very high pay."

And he further states that—

> The actors' "corporation included a priest (of Dionysus) at the head, who still remained a performer; a treasurer; dramatic poets of new tragedies and comedies and odes; principal actors of both tragedy and comedy . . . and musicians of various kinds."

From Rome, for reasons already indicated, we do not get much evidence. Still there is some.

> The authorities . . . out of regard for the Greek Andronikos "conceded to the guild of poets and actors a place for their common worship in the temple of Minerva."

Nor do modern days fail to furnish a few, though not many, illustrations of the integrating tendency. A slight organization is given by the Actors' Benevolent Fund. The dramatic writers have an agency for collecting the amounts due to them for the performance of their pieces, and are to that extent combined. And then we have a special newspaper, *The Era*, which forms a medium for communication, by advertisements, between all kinds of stage-performers and those who wish to engage them, as well as an organ for representing the interests of the stage and the semi-dramatic music-hall.

[After the above chapter was written my attention was drawn to a passage in the late Prof. Henry Morley's work, *A First Sketch of English Literature* (p. 209), which in short space yields verification for the various leading propositions contained in it and in the preceding chapter:—

"Our English ballads are akin to those which also among the Scandinavians became a familiar social amusement of the people. They were recited by one of a company with animation and with varying expression, while the rest kept time, often with joined hands forming a circle, advancing, retiring, balancing, sometimes remaining still, and, by various movements and gestures, followed changes of emotion in the story. Not only in Spain did the people keep time by dance movement to the measure of the ballad, for even to this day one may see, in the Faroe Islands, how winter evenings of the North were cheered with ballad recitations, during which, according to the old northern fashion, gestures and movements of the listeners expressed emotions of the story as the people danced to their old ballads and songs."

Here, then, as in the Hebrew triumphal reception of the living hero, and the Greek worship of the apotheosized hero, we see a union of music and the dance, and with them a union of rhythmical speech with some dramatic representation of the incidents described, and of the emotions caused by the description. We see that everywhere there has tended to bud out afresh the combined manifestations of exalted feeling from which these various arts originate. Another fact is forced upon our attention. We are shown that in all cases, while there arises some one of a group who becomes singer or reciter, the rest assume the character of chorus. This segregation, which characterized the religious worship of the Greeks and characterized also their dramatic representations, is not only displayed in later times by the cathedral choir, which shares the service with the solo-singers, and by the operatic chorus which does the like on the stage, but is also displayed by the choral accompanists described in the above passage, and even now survives among us as the chorus which habitually winds up the successive verses of a convivial song in a public house.]

Describing a lecture by Dean Buckland on Kent's Cavern, Sir Henry Ackland says that the lecturer "paced like a Franciscan preacher up and down behind a long show-case, up two steps, in a room in the old Clarendon (at Oxford). He had in his hands a huge hyena's skull. He suddenly dashed down the steps, rushed, skull in hand, at the first undergraduate on the front bench, and shouted, 'What rules the world?' The youth, terrified, threw himself against the next back seat, and answered not a word. He rushed then on me, pointing the hyena full in my face: 'What rules the world?' 'Haven't an idea,' I said. 'The stomach, sir,' he said (again mounting his rostrum), 'rules the world. The great ones eat the less, and the less the lesser still.'"

NEW CHAPTERS IN THE WARFARE OF SCIENCE.

XX.—FROM THE DIVINE ORACLES TO THE HIGHER CRITICISM.

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III. THE CONTINUED GROWTH OF SCIENTIFIC INTERPRETATION.

THE science of biblical criticism was, as we have seen, first developed mainly in Germany and Holland. Many considerations there, as elsewhere, combined to deter men from opening new paths to truth: not even in those countries were these the paths to preferment; but there at least the sturdy Teutonic love of truth for truth's sake found no such obstacles as in other parts of Europe. Fair investigation of biblical subjects had not there been extirpated, as in Italy and Spain; nor had it been forced into channels which led nowhither, as in France and southern Germany; nor were men who might otherwise have pursued it dazzled and drawn away from it by the multitude of splendid prizes for plausibility, for sophistry, or for silence displayed before the ecclesiastical vision in England. In the frugal homes of North German and Dutch professors and pastors high thinking on these great subjects went steadily on, and the "liberty of teaching," which is the glory of the northern Continental universities, while it did not secure honest thinkers against vexations, did at least protect them against the persecutions which, in other countries, would have thwarted their studies, and starved their families.

In England the admission of the new current of thought was apparently impossible. The traditional system of biblical interpretation seemed established on British soil forever. It was knit into the whole fabric of thought and observance; it was protected by the most justly esteemed hierarchy the world has ever seen; it was intrenched behind the bishops' palaces, the cathedral stalls, the professors' chairs, the country parsonages—all these, as a rule, the seats of high endeavor and beautiful culture. The older thought held a controlling voice in the senate of the nation, it was dear to the hearts of all classes, it was superbly endowed, every strong thinker seemed to hold a brief for it, or to be in receipt of its retaining fee.

While there was inevitably much alloy of worldly wisdom in the opposition to the new current, no just thinker can deny far higher motives to many, perhaps to most, of the ecclesiastics who were resolute against it. The evangelical movement incarnate in the Wesleys had not spent its strength; the movement initiated by Pusey, Newman, Keble, and their compeers was in full force.

The æsthetic reaction, represented on the Continent by Chateaubriand, Manzoni, and Victor Hugo, and in England by Walter Scott, Pugin, Ruskin, and, above all, by Wordsworth, came in to give strength to this barrier. Under the magic of the men who led in this reaction, cathedrals and churches, which in the previous century had been regarded by men of culture as mere barbaric masses of stone and mortar, to be masked without by classic colonnades and within by rococo work in stucco and *papier maché*, became even more beloved than in the thirteenth century. Even men who were repelled by theological disputations were fascinated and made devoted reactionists by the newly revealed beauties of mediæval architecture and ritual.*

The center and fortress of this vast system, and of the reaction against the philosophy of the eighteenth century, was the University of Oxford. Orthodoxy was its vaunt, and a special exponent of its spirit and object of its admiration was its member of Parliament, Mr. William Ewart Gladstone, who, having begun his political career by a labored plea for the union of church and state, ended it by giving that union what is likely to be a death-blow. The mob at the circus of Constantinople in the days of the Byzantine emperors was not more wildly orthodox than the mob of students at this foremost seat of learning of the Anglo-Saxon race during the middle decades of the nineteenth century. A curious proof of this had been displayed just before the end of that period. The minister of the United States at the Court of St. James was then Edward Everett. He was undoubtedly the most accomplished scholar and one of the foremost statesmen that America had produced; his eloquence in early life had made him perhaps the most admired of American preachers; his classical learning had at a later period made him Professor of Greek at Harvard; he had successfully edited the leading American review, and had taken a high place in American literature; he had been ten years a member of Congress; he had been again and again elected Governor of Massachusetts; and in all these posts he had

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* A very curious example of this insensibility of persons of really high culture is to be found in American literature toward the end of the eighteenth century. Mrs. Adams, wife of John Adams, afterward President of the United States, but at that time Minister to England, one of the most gifted women of her time, speaking, in her very interesting letters from England, of her journey to the seashore, refers to Canterbury Cathedral, seen from her carriage windows, and which she evidently did not take the trouble to enter, as "looking like a vast prison." So, too, about the same time, Thomas Jefferson, the American plenipotentiary in France, a devoted lover of classical and Renaissance architecture, giving an account of his journey from Strasburg to Paris, never refers to any of the beautiful cathedrals or churches upon his route.

For the alloy of interested motives among English church dignitaries, see the pungent criticism of Bishop Hampden by Canon Liddon, in his Life of Pusey, vol. i, p. 363.

shown amply those qualities which afterward made him President of Harvard, Secretary of State of the United States, and a United States Senator. His character and attainments were of the highest, and, as he was then occupying the foremost place in the diplomatic service of his country, he was invited to receive an appropriate honorary degree at Oxford. But on his presentation for it in the Sheldonian Theater there came a revelation to the people he represented, and indeed to all Christendom: a riot having been carefully prepared beforehand by sundry zealots, he was most grossly and ingeniously insulted by the mob of undergraduates and bachelors of arts in the galleries and masters of arts on the floor; and the reason for this was that, though by no means radical in his religious opinions, he was thought to have been in his early life, and to be possibly at that time, below what was then the Oxford fashion in belief, or rather feeling, regarding the mystery of the Trinity.

At the center of biblical teaching at Oxford sat Pusey, Regius Professor of Hebrew, a scholar who had himself remained for a time at a German university, and who early in life had embodied so much of the German spirit as to expose himself to suspicion and even to attack. One charge against him at that time shows curiously what was then expected of a man perfectly sound in the older Anglican theology. He had ventured to defend Holy Writ with the argument that there were fishes actually existing which could have swallowed the prophet Jonah. The argument proved unfortunate. He was attacked on the scriptural ground that the fish which swallowed Jonah was created for that express purpose. He, like others, fell back under the charm of the old system: his ideas gave force to the reaction: in the quiet of his study, which, especially after the death of his son, became a hermitage, he relapsed into patristic and mediæval conceptions of Christianity, enforcing them from the pulpit and in his published works. He now virtually accepted the famous dictum of St. Hilary of Poictiers—that one is first to find what is to be believed, and then to search the Scriptures for proofs of it. His devotion to the main features of the older interpretation was seen at its strongest in his utterances regarding the book of Daniel. Just as Cardinal Bellarmine had insisted that the doctrine of the Incarnation depends upon the retention of the Ptolemaic astronomy; just as Wesley had insisted that the truth of the Bible depends on the reality of witchcraft; just as Peter Martyr had made everything sacred depend on the literal acceptance of Genesis; just as Bishop Warburton had insisted that Christianity absolutely depends upon a right interpretation of the prophecies regarding Antichrist—so did Pusey now virtually insist that the whole claim of Christianity upon the world depends upon the early date of the

book of Daniel. Happily, though the Ptolemaic astronomy and witchcraft, and the Genesis legends of Creation, and the prophecies regarding Antichrist, and the early date of the book of Daniel have now been relegated to the limbo of delusions, Christianity has but come forth the stronger.

Nothing seemed less likely than that such a vast intrenched camp as that of which Oxford was the center could be carried by an effort proceeding from a few isolated German and Dutch scholars. Yet it was the unexpected which occurred; and it is instructive to note that, even at the period when the champions of the older thought were to all appearance impregnably intrenched in England, a way had been opened into their citadel, and that the most effective agents in preparing it were really the very men in the universities and cathedral chapters who had most distinguished themselves by uncompromising and intolerant orthodoxy.

A rapid survey of the history of general literary criticism at that epoch will reveal this fact fully. During the last decade of the seventeenth century there had taken place the famous controversy over the Letters of Phalaris, in which, against Charles Boyle and his supporters at Oxford, was pitted Richard Bentley at Cambridge, who insisted that the letters were spurious. In the series of battles royal which followed, although Boyle, aided by Atterbury, afterward so noted for his mingled ecclesiastical and political intrigues, had gained a temporary triumph by wit and humor, Bentley's final attack had proved irresistible. Drawing from the stores of his wonderfully wide and minute knowledge, he showed that the letters could not have been written in the time of Phalaris—proving this by an exhibition of their style, which could not then have been in use, of their reference to events which had not then taken place, and of a mass of considerations which no one but a scholar almost miraculously gifted could have marshaled so fully. The controversy had attracted attention not only in England but throughout Europe. With Bentley's reply it had ended. In spite of public applause at Atterbury's wit, scholars throughout the world acknowledged Bentley's victory: he was recognized as the foremost classical scholar of his time; the mastership of Trinity, which he accepted, and the Bristol bishopric, which he rejected, were his formal reward.

Although in his new position as head of the greatest college in England, he went to extreme lengths on the orthodox side in biblical theology, consenting even to support the doctrine that the Hebrew punctuation was divinely inspired, this was as nothing compared with the influence of the system of criticism which he introduced into English studies of classical literature in preparing

the way for the application of a similar system to all literature, whether called sacred or profane.

Up to that period there had really been no adequate criticism of ancient literature. Whatever name had been attached to any ancient writings was usually accepted as the name of the author; whatever text was imputed to an author was settled generally on authority. But with Bentley began a new epoch. His acute intellect and exquisite touch revealed clearly to English scholars the new science of criticism and familiarized the minds of thinking men generally with the idea that the texts of ancient literature must be submitted to this science. Henceforward a new spirit reigned among the best classical scholars, prophetic of more and more light in the greater field of sacred literature. Scholars, of whom Porson was chief, followed out this method, and though at times, as in Porson's own case, they were warned off, with much loss and damage, from the application of it to the sacred text, they kept alive the better tradition.

A hundred years after Bentley's main efforts appeared in Germany another epoch-making book—Wolf's Introduction to Homer. In this was broached the theory that the Iliad and Odyssey are not the works of a single great poet, but are made up of ballad literature wrought into unity by more or less skillful editing. In spite of various changes and phases of opinion on this subject since Wolf's day, he dealt a killing blow at the idea that classical works are necessarily to be taken at what may be termed their face value.

More and more clearly it was seen that the ideas of early copyists and even of early possessors of masterpieces in ancient literature were entirely different from those to which the modern world is accustomed. It was seen that manipulations and interpolations in the text by copyists and possessors had long been considered not merely venial sins, but matters of right, and that even the issuing of whole books under assumed names had been practiced freely.

In 1811 a light akin to that thrown by Bentley and Wolf upon ancient literature was thrown by Niebuhr upon ancient history. In his History of Rome the application of scientific principles to the examination of historical sources was for the first time exhibited largely and brilliantly. Up to that period the time-honored utterances of ancient authorities had been, as a rule, accepted as final: no breaking away, even from the most absurd of them, was looked upon with favor, and any one presuming to go behind them was regarded as troublesome and even as dangerous.

Through this sacred conventionalism Niebuhr broke fearlessly, and, though at times overcritical, he struck from the early history of Rome a vast mass of accretions, and gave to the world a

residue infinitely more valuable than the original amalgam of myth, legend, and chronicle.

His methods were especially brought to bear on English history by one of the truest men and noblest scholars that the English race has produced—Arnold of Rugby—and, in spite of the inevitable heavy conservatism, were allowed to do their work in the field of ancient history as well as in that of ancient classical literature.

The place of myth in history thus became more and more understood, and historical foundations, at least so far as *secular* history was concerned, were henceforth dealt with in a scientific spirit. The extension of this new treatment to *all* ancient literature and history was now simply a matter of time.

Such an extension had already begun, for in 1829 had appeared Milman's History of the Jews. In this work came a further evolution of the truths and methods suggested by Bentley, Wolf, and Niebuhr, and their application to sacred history was made strikingly evident. Milman, though a clergyman, treated the history of the chosen people in the light of modern knowledge of Oriental and especially of Semitic peoples. He exhibited sundry great biblical personages of the wandering days of Israel as sheiks or emirs or Bedouin chieftains, and the tribes of Israel as obedient then to the same general laws, customs, and ideas as govern wandering tribes in the same region now. He dealt with conflicting sources somewhat in the spirit of Bentley, and with the mythical, legendary, and miraculous somewhat in the spirit of Niebuhr. This treatment of the history of the Jews, simply as the development of an Oriental tribe, raised great opposition. Such champions of orthodoxy as Bishop Mant and Dr. Faussett straightway took the field, and with such effect that the Family Library, a very valuable series in which Milman's history appeared, was put under the ban and its further publication stopped. For years Milman, though a man of exquisite literary and lofty historical gifts, as well as of most honorable character, was debarred from preferment and outstripped by ecclesiastics vastly inferior to him in everything save worldly wisdom; for years he was passed in the race for honors by divines who were content either to hold briefs for all the contemporary unreason which happened to be popular or to keep their mouths shut altogether. This opposition to him extended to his works. For many years they were sneered at, decried, and kept from the public as far as possible.

Fortunately, the progress of events lifted him, before the closing years of his life, above all this opposition. As Dean of St. Paul's he really outranked the contemporary archbishops; he lived to see his main ideas accepted, and his History of Latin

Christianity received as certainly one of the most valuable, and no less certainly the most attractive, of all church histories ever written.

The two great English histories of Greece—that by Thirlwall, which was finished, and that by Grote, which was begun, in the middle years of the nineteenth century—came in to strengthen this new development. By application of the critical method to historical sources, by pointing out more and more fully the inevitable part played by myth and legend in early chronicles, by displaying more and more clearly the ease with which interpolations of texts, falsifications of statements, and attributions to pretended authors were made, they paved the way still further toward a just and fruitful study of sacred literature.*

Down to the middle of the nineteenth century the traditionally orthodox side of English scholarship, while it had not been able to maintain any effective quarantine against Continental criticism of classical literature, had been able to keep up barriers fairly strong against Continental discussions of sacred literature. But in the second half of the nineteenth century these barriers were broken at many points, and, the stream of German thought being united with the current of devotion to truth in England, there appeared early in 1860 a modest volume entitled Essays and Reviews. This work discussed various subjects in which the older theological positions had been rendered untenable by modern research, and brought to bear upon them the views of the newer school of biblical interpretation. The authors were, as a rule, scholars in the prime of life, holding influential positions in the universities and public schools. They were seven—the first being Dr. Temple, a successor of Arnold at Rugby; and the others, the Rev. Dr. Rowland Williams, Prof. Baden Powell, the Rev. H.

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* For Mr. Gladstone's earlier opinion, see his Church and State and Macaulay's review of it. For Pusey, see Mozley, Ward, Newman's Apologia, Dean Church, etc., and especially his Life by Liddon. Very characteristic touches are given in vol. i, showing the origin of many of his opinions (see letter on p. 184). For the scandalous treatment of Mr. Everett by the clerical mob at Oxford, see a rather jaunty account of the preparations and of the whole performance in a letter written at the time from Oxford by the late Dean Church in The Life and Letters of Dean Church, London, 1894, pp. 40, 41. For a succinct and brilliant history of the Bentley-Boyle controversy, see Macaulay's article on Bentley in the Encyclopædia Britannica; also Beard's Hibbert Lectures for 1893, pp. 344, 345; also Dissertation in Bentley's works, edited by Dyce, London, 1836, vol. i, especially the preface. For Wolf, see his Prolegomena ad Homerum, Halle, 1795; for its effects, see the admirable brief statement in Beard, as above, p. 345. For Niebuhr, see his Roman History, translated by Hare and Thirlwall, London, 1828; also Beard, as above. For Milman's view, see, as a specimen, his History of the Jews, last edition, especially pp. 15–27. For a noble tribute to his character, see the preface to Lecky's History of European Morals. For Thirlwall, see his History of Greece, *passim*; also his letters; also his Charge of the Bishop of St. David's, 1863.

B. Wilson, Mr. C. W. Goodwin, the Rev. Mark Pattison, and the Rev. Prof. Jowett—the only one of the seven not in holy orders being Goodwin. All the articles were important, though the first, by Temple, on The Education of the World, and the last, by Jowett, on The Interpretation of Scripture, being the most moderate, served most effectually as entering wedges into the old tradition.

At first no great attention was paid the book, the only notice being the usual attempts in sundry clerical newspapers to pooh-pooh it. But in October, 1860, appeared in the Westminster Review an article exulting in the work as an evidence that the new critical method had at last penetrated the Church of England. The opportunity for defending the Church was at once seized by no less a personage than Bishop Wilberforce, of Oxford, the same who a few months before had secured a fame more lasting than enviable by his attacks on Darwin and the evolutionary theory. His first onslaught was made in a charge to his clergy. This he followed up with an article, in the Quarterly Review, very explosive in its rhetoric, much like that which he had devoted in the same periodical to Darwin. The bishop declared that the work tended "toward infidelity, if not to atheism"; that the writers had been "guilty of criminal levity"; that, with the exception of the essay by Dr. Temple, their writings were "full of sophistries and skepticisms." He was especially bitter against Prof. Jowett's dictum, "Interpret the Scripture like any other book"; he insisted that Mr. Goodwin's treatment of the Mosaic account of the Origin of Man "sweeps away the whole basis of inspiration and leaves no place for the Incarnation"; and through the article were scattered such rhetorical adornments as the words "infidel," "atheistic," "false," "wanton," and the like. It at once attracted wide attention, but its most immediate effect was to make the fortune of Essays and Reviews, which was straightway demanded on every hand, went through edition after edition, and became a power in the land. At this a panic began, and with the usual results of panic—much folly and some cruelty. Addresses from clergy and laity, many of them frantic with rage and fear, poured in upon the bishops, begging them to save Christianity and the Church; a storm of abuse arose; the seven essayists were stigmatized as "the seven extinguishers of the seven lamps of the Apocalypse," "the seven champions *not* of Christendom." As a result of all this pressure, Sumner, Archbishop of Canterbury, one of the last of the old, kindly, bewigged pluralists of the Georgian period, headed a declaration, which was signed by the Archbishop of York and a long list of bishops, expressing pain at the appearance of the book, but doubts as to the possibility of any effective dealing with it. This letter only made matters worse.

The orthodox decried it as timid and the liberals denounced it as irregular. The same influences were exerted in the sister island, and the Protestant archbishops in Ireland issued a joint letter warning the faithful against the "disingenuousness" of the book. Everything seemed to increase the ferment. A meeting of clergy and laity having been held at Oxford in the matter of electing a Professor of Sanskrit, the older orthodox party having made every effort to defeat the eminent scholar Max Müller, and all in vain, found relief after their defeat in new denunciations of Essays and Reviews.

Of the two prelates who might have been expected to breast the storm, Tait, Bishop of London, afterward Archbishop of Canterbury, bent to it for a period, though he soon recovered himself and did good service; the other, Thirlwall, Bishop of St. David's, bided his time, and, when the proper moment came, struck most effective blows for truth and justice.

Tait, large-minded and shrewd, one of the most statesmanlike of prelates, at first endeavored to detach Temple and Jowett from their associates, but though Temple was broken down with a load of care, and especially by the fact that he had upon his shoulders the school at Rugby, whose patrons had become alarmed at his connection with the book, he showed a most refreshing courage and manliness. A passage from his letters to the Bishop of London runs as follows: "With regard to my own conduct I can only say that nothing on earth will induce me to do what you propose. I do not judge for others, but in me it would be base and untrue." On another occasion Dr. Temple, when pressed in the interest of the great institution of learning under his care to detach himself from his associates in writing the book, declared to a meeting of the masters of the school that if any statements were made to the effect that he disapproved of the other writers in the volume, he should probably find it his duty to contradict them. Another of these letters to the Bishop of London contains sundry passages of great force. One is as follows: "Many years ago you urged us from the university pulpit to undertake the critical study of the Bible. You said that it was a dangerous study, but indispensable. You described its difficulties, and those who listened must have felt a confidence (as I assuredly did, for I was there) that if they took your advice and entered on the task, you, at any rate, would never join in treating them unjustly if their study had brought with it the difficulties you described. Such a study, so full of difficulties, imperatively demands freedom for its condition. To tell a man to study, and yet bid him under heavy penalties to come to the same conclusions with those who have not studied, is to mock him. If the conclusions are prescribed, the study is precluded." And again, what, as coming from a man who has since held two

of the most important bishoprics in the English Church, is of great importance: "What can be a grosser superstition than the theory of literal inspiration? But because that has a regular footing, it is to be treated as a good man's mistake; while the courage to speak the truth about the first chapter of Genesis is a wanton piece of wickedness."

The storm howled on. In the Convocation of Canterbury it was especially violent. In the Lower House Archdeacon Denison insisted on the greatest severity, as he said, "for the sake of the young who are tainted, and corrupted, and thrust almost to hell by the action of this book." At another time the same eminent churchman declared: "Of all books in any language which I ever laid my hands on, this is incomparably the worst; it contains all the poison which is to be found in Tom Paine's Age of Reason, while it has the additional disadvantage of having been written by clergymen."

Hysterical as all this was, the Upper House was little more self-contained. Both Tait and Thirlwall, trying to make some headway against the swelling tide, were for a time beaten back by Wilberforce, who insisted on the duty of the Church to clear itself publicly from complicity with men who, as he said, "gave up God's word, creation, redemption, and the work of the Holy Ghost."

But the matter was brought to a curious issue by two prosecutions—one against the Rev. Dr. Williams by the Bishop of Salisbury; the other against the Rev. Mr. Wilson by one of his clerical brethren. The first result was that both these authors were sentenced to suspension from their offices for a year. At this the two condemned clergymen appealed to the Queen in Council. Upon the Judicial Committee to try the case in last resort sat the Lord Chancellor, the two Archbishops, and the Bishop of London. One occurrence now brought into especial relief the power of the older theological reasoning and ecclesiastical zeal to close the minds of the best of men to the simplest principles of right and justice. Among the men of his time most deservedly honored for lofty character, thorough scholarship, and keen perception of right and justice was Dr. Pusey. No one doubted then, and no one doubts now, that he would have gone to the stake sooner than knowingly countenance wrong or injustice; and yet we find him at this time writing a series of long and earnest letters to the Bishop of London, who, as a judge, was hearing this case, which involved the livelihood and even the good name of the men on trial, pointing out to the bishop the evil consequences which must follow should the authors of Essays and Reviews be acquitted, and virtually beseeching the judges, on grounds of expediency, to convict them. Happily, Bishop Tait was too just a man to be thrown off his bearings by appeals such as this.

The decision of the court, as finally rendered by the Lord Chancellor, virtually declared it to be no part of the duty of the tribunal to pronounce any opinion upon the book; that the court only had to do with certain extracts which had been presented. Among these was one adduced in support of a charge against Mr. Wilson—that he denied the doctrine of eternal punishment. On this the court decided that it did "not find in the formularies of the English Church any such distinct declaration upon the subject as to require it to punish the expression of a hope by a clergyman that even the ultimate pardon of the wicked who are condemned in the day of judgment may be consistent with the will of Almighty God." While the Archbishops dissented from this judgment, Bishop Tait united in it with the Lord Chancellor and the lay judges.

And now the panic broke out more severely than ever. Confusion became worse confounded. The earnest-minded insisted that the tribunal had virtually approved Essays and Reviews; the cynical remarked that it had "dismissed hell with costs." An alliance was made at once between the more zealous High and Low Church men, and Oxford became its headquarters; Dr. Pusey and Archdeacon Denison were among the leaders, and an impassioned declaration was posted to every clergyman in England and Ireland, with a letter begging him "for the love of God" to sign it. Thus it was that in a very short time eleven thousand signatures were obtained. Besides this, deputations claiming to represent one hundred and thirty-seven thousand laymen waited on the Archbishops to thank them for dissenting from the judgment. The Convocation of Canterbury also plunged into the fray, Bishop Wilberforce being the champion of the older orthodoxy, and Bishop Tait of the new. Caustic was the speech made by Bishop Thirlwall, in which he declared that he considered the eleven thousand names, headed by that of Pusey, attached to the Oxford declaration "in the light of a row of figures preceded by a decimal point, so that, however far the series may be advanced, it never can rise to the value of a single unit."

In spite of all that could be done, the act of condemnation was carried in Convocation.

The last main echo of this whole struggle against the newer mode of interpretation was seen when the Chancellor, referring to the matter in the House of Lords, characterized the ecclesiastical act as "simply a series of well-lubricated terms—a sentence so oily and saponaceous that no one can grasp it; like an eel, it slips through your fingers, and is simply nothing."

The word "saponaceous" necessarily elicited a bitter retort from Bishop Wilberforce; but perhaps the most valuable judgment on the whole matter was rendered by Bishop Tait, who de-

clared, "These things have so effectually frightened the clergy that I think there is scarcely a Bishop on the bench, unless it be the Bishop of St. David's (Thirlwall), that is not useless for the purpose of preventing the widespread alienation of intelligent men."

During the whole controversy, and for some time afterward, the press was burdened with replies, ponderous and pithy, vitriolic and unctuous, but in the main bearing the inevitable characteristics of pleas for inherited opinions stimulated by ample endowments.

The authors of the book seemed for a time likely to be swept out of the Church. One of the least daring but most eminent, finding himself apparently forsaken, seemed, though a man of very tough fiber, about to die of a broken heart; but sturdy English sense at last prevailed. The storm passed, and afterward came the still, small voice. Really sound thinkers throughout England, especially those who held no briefs for conventional orthodoxy, recognized the service rendered by the book. It was found that, after all, there existed even among churchmen a great mass of public opinion in favor of giving a full hearing to the reverent expression of honest thought, and inclined to distrust any cause which subjected fair play to zeal.

The authors of the work not only remained in the Church of England, but some of them have since represented the broader views, though not always with their early courage, in the highest and most influential positions in the Anglican Church.*

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* For the origin of Essays and Reviews, see Edinburgh Review, April, 1861, p. 463. For the reception of the book, see the Westminster Review, October, 1860. For the attack on it by Bishop Wilberforce, see his article in the Quarterly Review, January, 1861; for additional facts, Edinburgh Review, April, 1861, pp. 461 *et seq.* For action on the book by Convocation, see Dublin Review, May, 1861, citing Jelf *et al.*; also, Davidson's Life of Archbishop Tait, vol. i, chap. xii. For the Archiepiscopal Letter, see Dublin Review, as above; also, Life of Bishop Wilberforce by his son, London, 1882, vol. iii, pp. 4, 5. It is there stated that Wilberforce drew up the letter. For curious inside views of the Essays and Reviews controversy, including the course of Bishop Hampden, Tait, *et al.*, see Life of Bishop Wilberforce, by his son, as above, pp. 3–11; also 141–149. For the denunciation of the present Bishop of London (Temple) as a "leper," etc., see ibid., pp. 319, 320. For general treatment of Temple, see Fraser's Magazine, December, 1869. For very interesting correspondence, see Davidson's Life of Archbishop Tait, as above. For Archdeacon Denison's speeches, see ibid., vol. i, p. 302. For Dr. Pusey's letter to Bishop Tait, urging conviction of the Essayists and Reviewers, ibid., p. 314. For the striking letters of Dr. Temple, ibid., pp. 290 *et seq.*; also, The Life and Letters of Dean Stanley. For replies, see Charge of the Bishop of Oxford, 1863; also, Replies to Essays and Reviews, Parker, London, with preface by Wilberforce; also, Aids to Faith, edited by the Bishop of Gloucester, London, 1861; also, those by Jelf, Burgon, *et al.* For the legal proceedings, see Quarterly Review, April, 1864; also Davidson, as above. For Bishop Thirlwall's speech, see Chronicles of Convocation, quoted in Life of Tait, vol. i, p. 320. For Tait's tribute to Thirlwall, see Life of Tait, vol. i, p. 325. For a remarkably able review, and in most charming form, of

ART AND EYESIGHT.

By LUCIEN HOWE, M. D.,
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THERE was perhaps no more interesting object at the Columbian Exposition, as an example of a developing appreciation, than the typical Illinois farmer as he stood surprised and bewildered before some of the works of the modern school of painters. His verdict in many instances was doubtless like that of the small boy upon the decorative attempts of an artistic aunt when he said, "It do look awful." Apparently the effect upon at least one such visitor was even more appalling. Perhaps he had been gazing at the various yearnings of the impressionists, or was lost in the labyrinth of color, but at any rate he accosted a bystander in hot haste with "Mister, can you tell me the handiest way to get out of this 'ere place?" If others were not in equal haste to leave the place, they certainly went away questioning seriously what causes had combined to produce some of the conspicuous phases of modern art. Perhaps an explanation can be offered by science. At least, when we examine into the subject we find that the vision of artists is, as a rule, more imperfect than that of other persons. Where this is a not natural defect, artists find it convenient or necessary in their work to make their vision purposely imperfect, and in consequence do not place on canvas what the eye usually sees. Hence a discrepancy between Nature, as seen by the ordinary observer, and its alleged representation by some artists.

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the ideas of Bishop Wilberforce and Lord Chancellor Westbury, see H. D. Traill, The New Lucian, first dialogue. For the cynical phrase referred to, see Nash, Life of Lord Westbury, vol. ii, p. 78, where the noted epitaph is given, as follows:

"Richard Baron Westbury,
Lord High Chancellor of England.
He was an eminent Christian,
An energetic and merciful Statesman,
And a still more eminent and merciful Judge.
During his three years' tenure of office
He abolished the ancient method of conveying land,
The time-honored institution of the Insolvents' Court,
And
The Eternity of Punishment.
Toward the close of his earthly career,
In the Judicial Committee of the Privy Council,
He dismissed Hell with costs,
And took away from Orthodox members of the
Church of England
Their last hope of everlasting damnation."

The chief imperfection in the vision to which I refer is astigmatism, although either with that, or independently of it, there is usually with artists excessive contraction of the muscle used in focusing the eye—the so-called ciliary muscle. The majority of people have become somewhat familiar with the term astigmatism and its meaning, but, as it involves a rather complicated principle in optics, it may be well to define it here. Technically it might be described as an asymmetry of the eye in which the radius of curvature in one meridian is greater or less than the radius of curvature in another. This definition may be easily understood by a simple illustration. If the transparent portion in the front part of the eye, known as the cornea, were perfectly regular, like the surface of the ordinary sunglass, the rays of light would all tend to converge to a single point; but if the globe were compressed in any one direction—for example, from above downward—then this transparent portion of the eye would not have a regular curvature, but would be somewhat like the top of a Derby hat, held with the long diameter horizontally and the convex surface forward. Practically this is what usually exists in the human eye. As the globe is compressed above and below by the upper and lower lids, it is to a certain extent flattened. This is the usual form of astigmatism, or astigmatism with the rule, as it is called. Other causes tend to make the axes of these two curvatures oblique to each other, or may change their position in various ways, which need not be considered here.

According to the popular idea, the human eye is a perfect instrument, but this, in the vast majority of cases, is not the truth. Nearly every one is astigmatic. Many a person whose eyes are quite imperfect would laugh at the idea if this were told him. He has perhaps always prided himself upon having the best of vision. But the fact is that only a very small per cent of eyes are really free from this unequal curvature which we call astigmatism.

One series of observations made by Dr. Roosa of two hundred eyes, whose owners supposed them to be perfect, and which were apparently perfectly normal, showed that only about one per cent were, beyond question, absolutely perfect, and my own investigation in the same direction would fully corroborate this. If, therefore, a variation from the normal type is so frequent, it is but natural to suppose that artists should have at least their share of astigmatism. But the fact is that among artists astigmatism is not only more frequent, but also that it exists, on the average, in a higher degree, probably, than among any other class of persons.

We can understand the reason for this if for a moment we

observe an artist at his work. Having arranged on his palette a variety of pigments, he stands before the easel and applies them to the canvas, but at intervals steps back some few feet in order to get the effect of distance, as he says. It should be noticed that almost without exception the artist when doing this partly closes his eyes, pressing the lids together, making "*clingement*" as the French call it, because, as he explains, "better effects" are thus obtained. At the same time he tips his head from one side to the other, the reason for which we will consider later. Now, if the eyes of persons with ordinary occupations are changed, as we have seen, by the pressure of the upper and lower lids upon the globe, it is but natural to infer that the same result would follow even in a greater degree with persons whose occupation from morning until night, year in and year out, is such as to cause them to practice to an unusual degree this habit of *clingement*, or lid pressure upon the cornea. Indeed, this fact has long since attracted the attention of investigators and has been demonstrated and elaborated by Bull, of Paris, and others. Dr. Bull experimented on his own eyes, having them measured exactly by an instrument of wonderful exactness known as the ophthalmometer while he was making this lid pressure. These measurements showed that even this slight momentary contraction of the lids produced a perceptible increase of the unequal curvature of the cornea, and also that a very high degree of astigmatism could with little effort be produced by pressure of the lids.

Very strong *a priori* reasons, therefore, lead us to expect that the eyes of artists are as a rule more imperfect than those of persons with other occupations. I have taken pains, however, to establish this fact by tests and measurements. The first results of that investigation are given in the American Journal of Ophthalmology for October, 1894, and tests have been made at intervals since then of the vision of artists, record being kept of the variety of work done, style preferred, whether the individual practiced lid pressure habitually or not, and other details of a technical nature. Excluding those on the one hand who were too young in the profession to be really classed as "artists," and on the other hand those whose eyes were practically in a diseased condition, the list thus far includes eighty-four artists, or one hundred and sixty-eight eyes.

Among these, not a single eye was found to be without some astigmatism. This is not surprising, but the degree of astigmatism is significant.

In the series of two hundred eyes already referred to as examined by Dr. Roosa, which had every indication of being absolutely perfect, an exact examination showed that there was, on the

average, a degree of astigmatism which technically would be written 0·68 of a *dioptre*, this *dioptre* corresponding to a certain weak glass used as the unit of measure.

Among artists, on the other hand, the examination showed that the average was 0·83 of a *dioptre*, thus being decidedly greater than with persons having other occupations.

It would be interesting to study the degree of this fault as related to the style of the artist, but the limits of this paper do not permit such a long digression. Moreover, this number is small, and there is always danger in generalizing from insufficient data, but I think it fair to say that these facts are sufficient to show the comparatively high degree of the astigmatism of artists, and I am confident that corroborative testimony will not be wanting when this subject is studied by others. Nor is this idea by any means a new one. It is true, exact measurements of the vision of so large a number of painters had not been previously made, but long ago the effects of astigmatism were so conspicuous in some well-known pictures as to attract attention.

A quarter of a century ago no oculist was more prominent than Prof. Liebreich, of London, or better able than he to speak on questions relating to optics. Unfortunately for that branch of science, he came into a fortune, and, giving up the labors of professional work, devoted himself to the study of painting, thus doubling his equipment for the investigation of such questions as these. He turned his attention to the pictures of Turner and Mulready, both of whom have prominent places in the National Gallery and at the Kensington Museum, and in the works of these artists Liebreich's trained sight discovered incontrovertible evidences of defective vision. These facts were brought out in 1863 by Liebreich in a communication to the Royal Institution which still lies buried among its archives.

"Till the year 1830," he says, in speaking of Turner, "all is normal. In 1831 a change in the coloring becomes for the first time perceptible, which gives to the works of Turner a peculiar character not found in any other master. Optically this is caused by an increased intensity of the diffused light proceeding from the most illuminated parts of the landscape. . . . From the year 1833 this diffusion of light becomes more and more vertical. It gradually increases during the following years. At first it can only be perceived by a careful examination of the pictures, but from the year 1839 the regular vertical streaks become apparent to every one. . . . It is a generally received opinion that Turner adopted a peculiar manner, that he exaggerated it more and more, and that his last works are the result of a deranged intellect. I am convinced of the incorrectness—I might almost say of the injustice—of this opinion. . . . According to my opinion, his manner

is exclusively the result of a change in the eyes, which developed itself during the last twenty years of his life. In consequence of it, the aspect of Nature gradually changed for him, while he con-

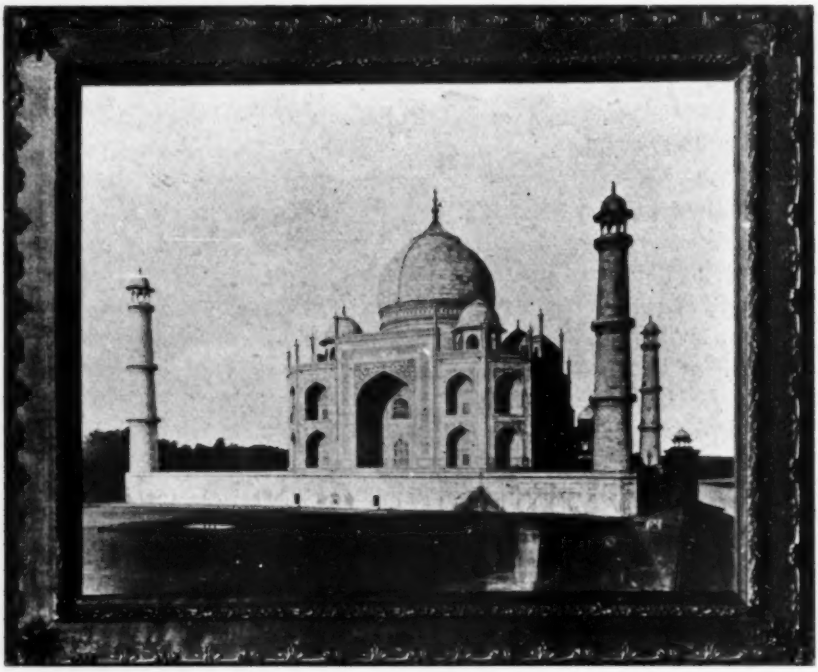


FIG. 1.

tinued in an unconscious, I might almost say in a naïve, manner to reproduce what he saw. . . ."

That astigmatism distorts objects can be easily demonstrated. It is well known that the structure of the human eye is practically the same as that of the photographer's camera. Ordinarily the image which falls on the glass plate of the camera is equally clear in every part, because the lenses in front are ground with spherical surfaces. Such a camera when properly directed at a picture like that of the Taj Mahal, for example, gives us on the glass plate a clear and undistorted image of the building, such as is seen in Fig. 1. If, now, we render the front glass of the camera slightly astigmatic, by placing in front of it a so-called cylindrical glass with the axis horizontal, it produces optically exactly the same effect as that obtained when the globe of the eye is pressed from above downward. Moreover, the degree of this distortion in any eye can be reproduced with perfect exactness by placing in front of the camera a cylindrical glass of proper strength. It will be remembered that the average degree of astigmatism with the artist's examined was found to be

0·83 of a *dioptre*, and for this experiment I have chosen one of the lenses which is very nearly the same strength. Of course, the effect is magnified, as the camera is larger than the eye. But the eye can recognize differences infinitely more minute than those which it is possible to reproduce here, and the physiological distortion is even greater than that which it is possible to represent on the printed page. A picture taken with such a combination of lenses is shown in Fig. 2. In this it will be noticed that while the vertical lines are all clearly marked the horizontal ones are blurred and indistinct. If, now, for any reason the globe of the eye has the same distortion from side to side instead of from above downward, this can be imitated by placing the cylindrical lens before our camera with the axis vertical instead of horizontal. The result is shown in Fig. 3. The effect in this case is to blur the lines which before were clear, and make clear those which were blurred. For example, the horizontal line extending

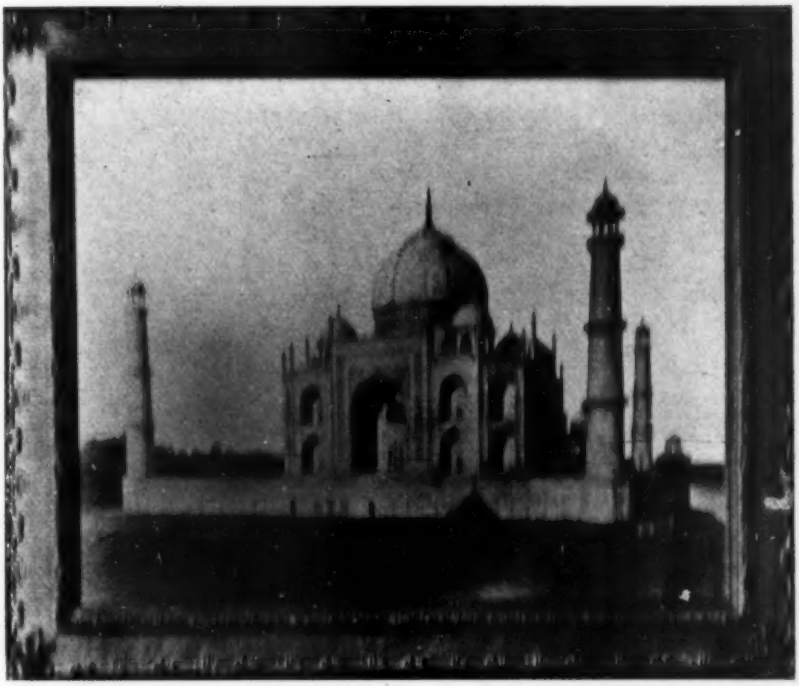


Fig. 2.

along the top of the wall of the terrace, and even some of the strata of the stones, can be distinguished, and the horizontal lines in the building itself are also well defined. On the contrary, the vertical lines are blurred. The pillars at the top of the tower and on the dome itself are all indistinct, while, as a whole, the build-

ing is broadened and the arches are apparently wider than is shown in Fig. 2.

In all these pictures the frame also is worthy of notice. In the first it has its true proportions; and in the second, it is distorted at the sides, and in the third, above and below.

There can be no question but that astigmatism even in a slight degree materially affects what the artist sees, and if it is true that he draws what he sees, does this not mean that his drawing tends to be proportionately faulty? Nor does it affect the vision for rectangular objects alone. This distortion is a constant quantity, and it does not take very exact study to see its effect in the drawing of the figure. For this reason, often an undue plumpness is given to some portions, while others are rendered emaciated and anæmic to a degree of which the originals were never guilty.

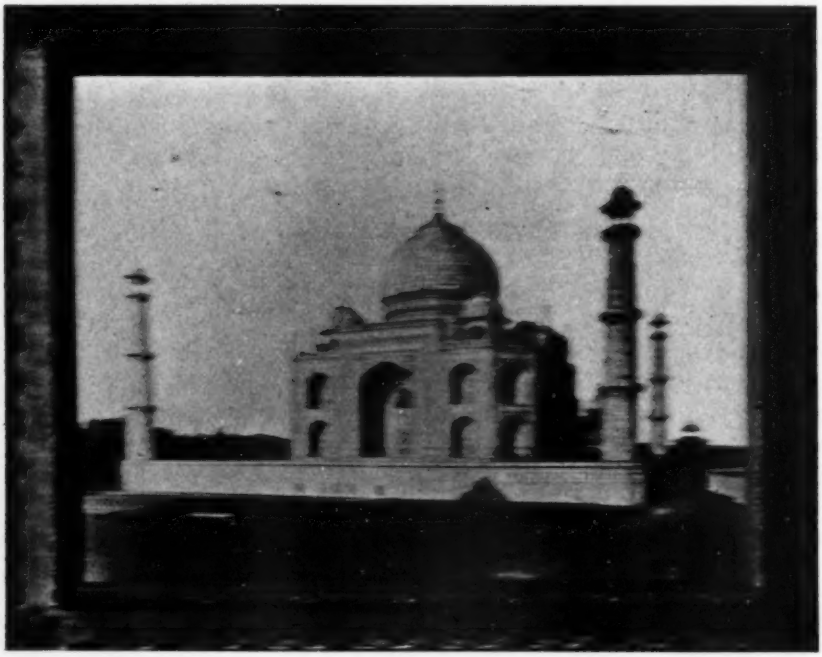
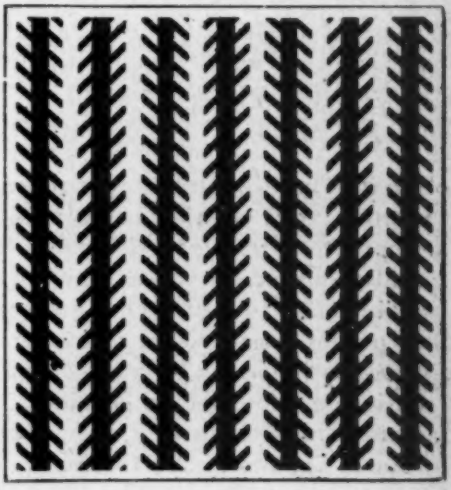


FIG. 3.

Another disadvantage of astigmatism to the artists is that lines really parallel appear to converge or diverge, when distorted by the blurring which astigmatism can produce. The reason of this would require too great a digression here. The practical fact is that as the blurring is unequal when different parts of the objects are differently illuminated, and as the direction of the apparent blurs depends somewhat upon the form of the object, lines which should be straight have their direction apparently changed.

This is shown in a modified way by the accompanying diagram.

If the page be tilted so as to be held in the line of vision, and if we "sight" along these heavy black lines, they are seen to be really parallel; and yet, when viewed as the page is ordinarily held, they appear inclined more or less to each other. Such an effect is produced only in exceptional cases, where the axis of the astigmatism varies in the two eyes, and this is therefore rather an unfair example. But the fact remains that the blurring of lines in certain directions may cause an artist to misrepresent very greatly the object which he is trying to reproduce.



Before leaving this phase of astigmatism it is worth while to note in passing a significant motion of the artist, already mentioned, in tipping his head from side to side, as he stands off to criticise his work. I am inclined to think he does this instinctively, in order to see better the errors in drawing caused by his own astigmatism.

The imperfect photographs of the Taj Mahal may serve to illustrate this point for some of the readers of this article. If one eye be closed (simply to exclude the correcting vision of the other), and if either of the astigmatic pictures be looked at while the book is rotated from side to side in the plane of the open page, one position can be found by most persons in which the lines are decidedly more distinct than in any other.

But, as the artist can not conveniently tip up the sides of his easel without disturbing also the equilibrium of brushes and paints and bottles, he simply steps back and tips his head.

Moreover, the critic does the same. He, too, instinctively wishes to obtain the clearest lines—for to some these blurred, astigmatic images are confusing, disagreeable, almost painful—and to obviate that, the stranger in the studio, when he comes to see the finished picture, tips the head just as did the artist when he was at his work. The more closely we observe actions called "instinctive," the more frequently do we find they have an underlying cause.

There is another imperfection of vision, more frequently artificial and temporary than due to any structural change. This is

imperfect focusing. To understand this, let us for a second time observe the artist before his easel. If he is painting a bunch of flowers, with a white rose near the center, and if he wishes this rose to stand out in strong relief, he focuses his eyes naturally and normally upon it, and reproduces on the canvas the same clearly defined, well-focused flower which he sees. To the other flowers of the cluster he does not care to give the same prominence, and sketches them with less distinctness, or else focuses his eyes purposely for a point in front of the bouquet or behind it, thus blurring the colored flowers and purposely transferring to the canvas an ill-defined image of them. For example, teachers often find fault with their pupils, saying, "The trouble is, you see too much; you should not paint so exactly." An artist, holding an important public position as a teacher of painting in Boston, recently showed me lenses which were used by the students when learning thus to focus the objects imperfectly. Given, then, this fact of imperfect vision on the part of the artist, either in the form of astigmatism or in the form of undue contraction of the focusing muscle, let us consider its effect in relation to three factors—namely, drawing, values, and color.

As to the first, imperfect vision is unquestionably a disadvantage, as we have seen. The draughtsman owes his power to two things—accuracy of eye, which enables him clearly to perceive forms; and dexterity of hand, which enables him to reproduce them. Truth in one is as indispensable as in the other.

Next, as to the question of values. This term, as we know, is used in a certain sense to express perspective, or, more exactly, the relative distance of an object in the foreground as compared with another more or less in the background. In the case of the bouquet, just cited, the white flower in the center, having the highest relative value, is painted exactly in focus. A certain amount of artificial adjustment of focus by the artist is an undoubted advantage for the rest of the bouquet, however, and the habit of focusing the eye for some point in front of the picture or beyond it is, therefore, practically universal among artists, though in most instances they are not conscious of the act. In a similar way the effects called technically "distance" and "atmosphere" are also best secured in this way. The two factors thus far considered relate to representations in black and white as well as to those in color.

We come now to consider the third factor, that of the mixing of colors. We shall find that this involves the blurring or overlapping of images on the retina, which can be caused by astigmatism, if it exists in sufficient degree, or by improper focusing. It is usually produced by both of these together and by another function dependent on the combination and

contrasting of colors. All this is done unconsciously by the observer.

To make this point clear, a slight digression is necessary to glance at the growth of painting. It must be remembered that the earlier artists were religious enthusiasts. First, they painted upon the walls of the basilicas and baptisteries; but as the early styles of architecture changed, and more and more of the wall space was encroached upon by windows, canvas came into use, and with opportunities thus increased painters grew more numerous and more proficient. Their methods of procedure were as simple as their faith, and there were but few efforts to produce unusual effects. The pigments were mixed on the palette, and thus mixed were transferred to the canvas. This was the method until recent times, and by that method the great masterpieces have been produced.

It is true that the works of some of the great colorists before which we bow down and worship to-day are not the pictures painted by these artists. The pigments they used have faded, and successive layers of varnish have changed them greatly. But in all, whether well preserved, in a slightly pathological condition, or in an advanced stage of decomposition, the point to be observed is, that the pigments were mixed on the palette just as they were placed on the canvas, and in looking at them no effort at accommodation of the eye or special focusing is required. If the eyes of the observer are opened in a natural manner, he sees just what was intended should be seen. In spite of certain variations from this type, that was the condition of the art of painting until the present generation. But, near the middle of this century a book was published by Chevreul on the Principles of Harmony and Contrasts of Colors, which by popularizing facts already known undoubtedly exerted an important influence on the artistic mind, especially in France. The principle to which I refer consists in this, that the pigments mixed on the palette and transferred to the canvas, as was the habit of earlier artists, do not produce upon the human retina so marked or so true an effect as when the proper pigments are placed unmixed but side by side on the canvas, and then viewed in such a blurred way that the rays from each are superimposed upon the retina. It is not simply a theory that the mixture of colors optically, produces effects quite different from those obtained by the mixture of corresponding pigments, but it is easily demonstrated. If we mix the rays of the spectrum, as can be done by means of a lens or concave mirror, the result is white light; but if the very same pigments, as pure as can be obtained, are mixed on the palette, we obtain not white, but a dark gray—indeed, in certain proportions we have almost a black resulting. Again, the commingling of the yellow and blue

of the spectrum produces *white*, as was first shown by Helmholtz, but when these pigments are mixed they produce *green*. Such examples might be multiplied to a considerable extent. The reason why the mixture of colors in the spectrum differs in the results from the mixture of pigments is due to the fact that the pigments are not pure colors. Every red contains some blue or yellow, the yellows contain some blue or red, and the blues contain some red or yellow. Not only does the actual mixture of pigments produce effects differing from those caused by the mixture of the same colors in the eye, but the mere juxtaposition of the two pigments on the canvas influences the color of each, even when they are both properly focused in the eye. Thus, if small spots of pure yellow and blue are placed side by side, we see that the yellow inclines to red and the blue to violet. But if the spots are blurred and blended by making the eye sufficiently astigmatic by improper focusing, then by this or other optical combination it is possible to obtain shades of gray. In a word, the combination is in a "higher key." These and similar facts have been gradually worked out on the one hand in the laboratory by the physicists, and on the other by those who were constantly experimenting with pigments as they were mixed on the palette. Only a few painters know the scientific principles involved, but many had stumbled upon the practical results, and of late a new and almost distinctive class has arisen, whose usual practice it is not to mix the colors on the palette, but, consciously or unconsciously, to so arrange them on the canvas that they blend in the eye when properly viewed. This is one of the distinctive features of the so-called school of impressionists. It is easy to see that unusual care and fine artistic sense must be exercised in attempting any such trick with pigments. A genius may succeed at this, but the result for a mere imitator is disastrous. The effect is that produced when a certain artist by chance sat down on his freshly prepared palette. "Ah!" said his friend, "that is the best picture you ever produced. Cut it out, call it 'An Old-time Garden,' and it will sell for a fortune." In spite of the ridicule which this class of painters has brought upon itself, it must be said in justification that the method has a certain basis of scientific truth, and that good effects, striking effects, if not the best effects, can often be obtained by this mixture of colors, not on the palette, but in the eye. But this method of arranging colors demands as its correlative a certain amount of imperfect vision. In order to see such pictures at their best, it is necessary to view them from a considerable distance, as we have seen the artist do in his studio, or else, approaching the picture, pinch the cornea by means of the lids into a marked degree of astigmatism, or, consciously or unconsciously, contract the ciliary muscle

so that the eye is really focused for a point in front of the picture. Under any one of these three conditions there can be produced on the retina an overlapping of the colors, or what is termed in optics circles of diffusion. It may be mentioned in this connection that one of the most distinguished leaders to-day of the school of impressionists in France, a master who has probably done more than any other to bring that style of painting to public attention, has one eye so imperfect as to be practically useless for his painting, and the other eye is distinctly astigmatic, besides having the changes in the hardening of the lens common to advancing years. This was shown by tests which I made less than two years ago. The question might be asked, Has every impressionist a marked degree of imperfect vision from astigmatism or from other causes? While I am convinced that this is the rule, there are, of course, a great many exceptions to it. Certainly the degree of impressionistic tendency shown is by no means in proportion to the astigmatism possessed by a given artist. Various causes in the individual cases combine to influence the results. Imitation of a popular style is undoubtedly a potent factor, and many artists of late have certainly modified their previous methods in the honest desire to get more light into their pictures, as they would say, or to paint in a higher key. While the artistic instinct itself may be unchangeable from age to age, it is not strange that the expression of that instinct in painting should strive for greater perfection, and in doing so make use of any aids which science may offer.

But we must not confuse this optical trick of the impressionist with his mental condition. It is well known that when the pictures of the extremists of this school were first exhibited in the Paris *Salon*, they were called the works of the impressionists, for the reason that they were supposed to represent the impression of the artists at the moment. They were expressions of the lyric mood, as it were, and represented, not Nature, but the mental attitude of the painter. (If purple shadows were given to a rock, and no one else had ever seen such shadows, that was of no consequence—simply, so much the worse for the rock. Real representation was not the aim.) When the original of a portrait complained that there was not the least resemblance to himself in the picture, the impressionist replied: "Of course not. This is not photography; it is art." With some subjects such idealism is convenient. But in the extreme it shows not an astigmatism of the eye, but of the brain. The two should not be confounded.

A few practical conclusions may be drawn from our study of art and eyesight. These are briefly:

1. As far as the artist is concerned, if he wishes to avoid increasing astigmatism, it is necessary for him to abstain from this

habit of making lid-pressure on the cornea, the resulting astigmatism being of no advantage, but always a disadvantage.

2. If he wishes to render himself relatively near-sighted, or, as he would state it, throw the eye out of focus, it is better to wear at his work a pair of convex glasses. The inconvenience of removing and replacing these could be obviated by spectacles made after the plan of the ordinary bifocal glasses, or, still better, by having the upper half cut away entirely, leaving for the lower a convex glass of such a strength as that individual would find most convenient for his special variety of work. In this way he is at least rid of the annoyance of constantly walking back and forward to obtain the effect of distance.

3. It is an undoubted advantage to every artist to ascertain the degree in which his eyes vary from the normal standard. Such a formula could be easily obtained. If the degree of error is but slight, of course it can be disregarded; if decided, and not properly corrected, knowledge of that variation from the normal in the artist's vision, if given in some way to the observer, would, without doubt, often win more favorable criticism for his work.

The logical and imaginative reader will perhaps picture to himself the art catalogue of the future, with a formula for the amount of imperfect vision (ametropia, as the oculists call it) added to each title. Thus:

No. 42. A Summer Morning. Myopic astigmatism, 1·5 *dioptre*, vertical meridian.

No. 44. He Cometh Not. Cylindrical, minus 0·5 *dioptre*, with spherical, minus 1·5, axis forty-five degrees.

This may seem rather like the "schedule of emotions," as it was once called, which was printed on the weekly programme in the earlier days of the Boston Symphony Orchestra, but none the less some such cataloguing of pictures would probably assist the critics and give the artist the satisfaction of more praise.

4. As the corollary of the last proposition it should be said that the observer, in order to see a picture to the best advantage, must adjust his vision to that of the artist who produced it. Most of us do this instinctively. Not only do we select the best point of view from which to observe a picture, but we recede from the painting until the lights and colors blend in just the right degree. In addition to that, many instinctively pinch the eyes together, producing thus a momentary astigmatism, such as the artist had produced in his own eye, and find the picture thus apparently improved. A most useful appliance for viewing pictures is the so-called stenopaic slit. This is merely a slit one or two millimetres in width in a card or thin plate of brass. Simple as this device is, but few persons are aware of how much it adds to the effect in viewing paintings, as it allows the rays of light in only

one meridian to pass through the cornea of the observer. If he wishes to look at a painting done by an artist whose vision is normal, or nearly so, the observer turns the slit around to correspond with the meridian of his own best vision. If, however, he looks at a picture in which it is desirable to have overlapping of the retinal images—at one, where the colors must be mixed in the eye, for example—it is necessary to rotate the slit to another position, usually at right angles to the first, and with this a canvas which before showed too clearly the blotches of color now becomes blended into a much more perfect whole. I would recommend this simple device to any one who has not already experimented with it. Thus, by adjusting our own personal equation of eyesight to that of the artist, we literally obtain his point of view. The colors are heightened, the daubs blend, and new beauties appear. Instead of seeking, like our friend mentioned at first, for "the handiest way to get out of this 'ere place," we are glad to stay longer to study and to enjoy. Here, as everywhere, it is art and science together that yield the richest result. If science is allowed to be the interpreter, we may gain a heightened enjoyment of art, and the artist a comforting increase of appreciation.

THE PHYSICAL ELEMENT IN EDUCATION.

By EUGENE L. RICHARDS,
PROFESSOR OF MATHEMATICS IN YALE UNIVERSITY.

IT would be as unwise as it is impossible to expect that every person engaged in education should be able to survey the whole field. Each educator takes a part, and is very apt to think that his or her part is the most important. Education, until quite recently, has been so widely regarded as brain culture that the whole trend of education is to develop the mind as one organ of the body, as if mind resided in the brain alone. And even those who know and admit that the mind is something more than brain, disregard the fact in their systems of education, following almost unconsciously the old ruts. Thus Bain says in one place: "The organ of mind is not the brain by itself; it is the brain, nerves, muscles, organs of sense, and viscera." And yet, in Education as a Science, he says: "Now, when we inquire into the meaning of physical education, we find it to be the rearing of a healthy human being by all the arts and devices of nursing, feeding, clothing, and general regimen. Mill includes this subject in his article, and Mr. Herbert Spencer devotes a very interesting chapter to it in his work on Education. It seems to me, however, that this department may be kept quite separate, important

though it be. It does not at all depend upon the principles and considerations that the educator, properly so called, has in view in the carrying on of his work. The discussion of this subject does not in any way help us in educational matters, as most commonly understood, nor does it derive any illumination from being placed side by side with the arts of the recognized teacher." And we have seen a Committee of Ten of the "recognized" teachers of our own land blocking out the time of the secondary schools without a single word of reference to the important matter of physical education.

The Committee of Fifteen, which lately met at Cleveland, Ohio, in their voluminous report on Education, did devote one short paragraph to physical culture. But they did not seem to grasp the vital connection between the growth of the mind and the development of the body; for they remark that "systematic physical training has for its object rather the will training than recreation"; and again: "Systematic physical exercise has its sufficient reason in its aid to a graceful use of the limbs, its development of muscles that are left unused or rudimentary unless called forth by special training, and for the help it gives to the teacher in the way of school discipline." The report makes physical culture subsidiary to other kinds of education; not as it should be considered—a *fundamental* and *necessary* part of education.

I have therefore thought that a few remarks on the physical element in education would be timely.

It is a suggestive fact that the ratio, by weight, of the brain to the body of a new-born infant is one to ten, while the ratio of the brain to the body of the average European adult man is one to forty-six. Does not this fact at the very outset of life point the way to a correct education? The body needs development till it attains maturity, if it is to have its appropriate growth. The brain needs care rather than special culture while the body is developing rapidly. Its appropriate culture for the years of growth is to be found in its supervision, direction, and control of the body.

If I were asked what should be the prime essential result of a man's education, I should say power, vigor. And by that I mean that a rightly educated man should have force in himself, of which he is master. And I do not hesitate to say that any education, however well it stores the mind with ideas or fills it with knowledge, and yet fails to cultivate this force, is so far a failure. I would extend my remarks so as to include similar statements about the education of woman. Her power may be of a different kind, but power she needs for the battle of life just as much as man needs his force. And until we educate our men rightly, and

our women also to be in this respect real helpmeets to men, we shall not have on this continent a race which is to remain. What Dr. Clark says, in the Building of a Brain, may well be quoted here: "On this continent races have been born and lived and disappeared. Mounds at the west, vestiges in Florida, and traces elsewhere proclaim at least two extinct races. The causes of their disappearance are undiscovered. We only know they are gone. The Indian, whom our ancestors confronted, was losing his hold on the continent when the Mayflower anchored in Plymouth Bay, and is now also rapidly disappearing. It remains to be seen if the Anglo-Saxon race, which has ventured upon a continent that has proved the tomb of antecedent races, can be more fortunate than they in maintaining a permanent grasp upon this western world."

How shall we develop this power? Regarding the new-born child as a bundle of latent forces, how shall we draw out these forces so that they shall be active, and yet be directed and controlled by an enlightened will? Only general suggestions can be offered. The order of development is important. The earliest attention should necessarily be given to the physical powers. Nutrition is of the first importance. Next comes motion, the exercise of muscles, and through these a certain development of mind and will. And these phenomena of motion on the part of children are so common, and, when we wish them to be quiet, so exasperating to us, that we miss their great importance in development. How can children grow without continual motion? Consider how large a part of our physical economy is dependent on motion. We pour food into the stomach, but the stomach is a muscular organ and does a great part of its work through muscular motion. It is to a certain extent dependent for its tone on the vigor of the muscular system. After the food is converted into chyle and sent drop by drop into the blood and is then passed through the oxygenizing process in the lungs, what is it that pumps it along the arteries but another muscular organ, the heart? And how much help this flow of nutritious blood to the very extremities of the system, into every nook and cranny of every organ of the body, derives from the action of the voluntary muscular system, we can hardly estimate. But we know the life current is quickened by exercise and slackened by the cessation of exercise. There is another way in which we know the influence of the voluntary muscular system. When more exercise is taken, more food is required to repair the waste, and there is better circulation of the blood.

Again, consider the senses, those avenues of knowledge to the knowing mind. Take the eye. It is not only a combination of lenses with a retina behind them sensitive to impressions. The lenses are furnished with adjusting muscles. And the ball itself

is fitted with other muscles to roll it in the socket and to direct it on objects which the will commands it to see. Then, too, there is the sense of touch, which, with sight, gives us knowledge of the outside world. How could it give us such complete information of our environment were it not supplemented by the muscles of the outstretched arm and the feeling hand? Our hearing is better because we have muscles to enable us to turn the head that we may listen. Smell and taste are more efficient because they are supplemented by muscles appropriate to their functions.

Then, if we take our social life, how large a part of it is dependent on speech! And speech itself would be impossible without the muscular power of taking and expelling breath and the movement of the muscles of the larynx. Without muscles the hand of the writer could not produce our books any more than the cunning hand of the artificer could work out the inventions of this inventive age. Knowledge itself, then, is dependent on muscles and the power of muscles on motion.

It is, therefore, a wise provision of Nature which implants in children a desire for play. By their very instincts they seek motion, and the exercise and growth of their bodies through motion.

But does the good effect of exercise end in the body? Is that simply larger and stronger? The mind, too, has its share of good. In the first place, the brain and nervous system are supplied with blood and more of it. The repair of the waste is more completely made. This of itself is one great gain. But in all use of the voluntary muscles there is, as the term implies, a necessary putting forth of will. The mind is exercised while the body works. And this is especially true in all exercises which require skill, in which the mind has an object to gain through the skillful use of the body. This mental element comes in very early in a child's life—as, for instance, in learning to walk, to swim, or to write. All through the years of childhood it accompanies motions in games, most mind being required in those games which require most skill. So those gymnastic exercises which call for combinations of muscles in action, and need quickness and exactness, are more useful for the majority of children and men than those requiring the use of strength alone. For, to attain success in games or exercises of skill, not only quickness of body is needed, but an alertness of mind, and often, too, quickness of the senses of sight and hearing. This mental element in certain athletic games explains, in a measure, their fascination. They furnish an exercise not for the body alone, but for the whole man—every part of his being, including his mind, his social nature, and even his moral nature, coming into play. This is particularly the case in games in which a number of players

are involved, so that individual skill must be subordinated to the good of the whole body of players. The individual must repress and control self and observe law. Children have the same discipline in their play when they engage in games requiring the observance of rules.

This mental element in games assigns to them the first place in any rational system of physical culture. The grind of the gymnasium is so distasteful to the generality of people that gymnastic exercise, whether free or with apparatus, is only sought as a last resort. But gymnasium work can be made interesting by variety and by competitions. By being made also a preparatory training for athletic sports, gymnastic exercises can be given an interest and a power which they would fail to possess if taken only from a sense of duty.

The more complete the exercise is for the whole system, the more complete is this development of the mind through the body. Therefore all supervision of the exercise of children should be in the line of removing obstacles to the free exercise of every muscle of the body. Care should be used to guard against the compression of any part of the body by tight clothing. Badly fitting, uncomfortable shoes often make the movements of the feet and lower limbs a torture, affecting, unfortunately, the carriage of the whole person, and producing ungraceful habits of walking.

The connection between the body and mind is so close that the working of every (even the smallest) muscle of the body must leave some trace in the mind. The education of the mind through the body is defective to the extent of every unused muscle. We see this plainly, according to Dr. Luys, quoted by Dr. Faries in his paper read last April: "When a limb has lost its function there is atrophy of certain parts of the gray matter of the brain, due to defective action of the motor cells." So that muscular exercise, besides conducing to the strength of the body, is necessary to the storing of force in the brain and nervous system. But this is not all. The brain has a great deal of its development in consequence of directing and controlling the use of the body through the muscular system. The more extensive this use of the muscles, the more complete the education. Interfere with this education by directing the will too early in life to conscious cerebration by means of books, and you not only check the development of the brain, but you deprive it also of a growth more important than knowledge can give it, and one which no subsequent effort can supply.

In support of this theory of the growth of mind and true brain power during the period of immaturity through the muscular system, I quote from Dr. Ladd's work on Psychology: "All our study hitherto has led us to emphasize greatly the influence

upon mental development of the constitution and functions of the muscular system. The condition and action of the muscles stand in reciprocal relation to the senses and to the feelings which form the necessary effective accompaniment of the senses. Furthermore, the striated (or so-called voluntary) muscles are organs of the will. In the complicated sensory motor apparatus all the most primary foundations of the intellectual life are laid."

This quotation is right in line with the fact that the first development of will comes through exercise of the muscles; for the first development of will, like all succeeding development of will, consists in overcoming resistance; and the first resistance to be overcome is physical. The child with flabby muscles has generally a defective will power. Men of strong physique have strong will power. Of course this will power to be effective must be educated and directed like any other power. But its foundation is laid in bodily power.

Another confirmation of the necessary connection between strength of body and power of mind is to be found in the history of the dominant races. The Greeks afforded the finest types of body of their times or of any succeeding times. They showed also that their intellectual activity was as remarkable as their physical development. They have produced a literature that will never die. The Roman supremacy, which lasted longer than the Greek, was founded on physical prowess. It also has left a law and a literature which are imperishable. The northern races of Europe, overcoming the Roman arms by sheer physical force, and appropriating what was best in the Roman polity, became the masters of the world. From those races—one more virile than the rest—the Saxon (now become the Anglo-Saxon) is through its descendants almost master of the present world. Moreover, all those races which declined, went down before races of stronger physical power. The corruption of the body by sloth and effeminate luxury was followed by a mental decline, just as softness and weakness of mind and will have always gone hand in hand with enervated, enfeebled bodies.

But I should be misunderstood if I leave the impression that muscular force is the only one to be considered. Even of the bodily forces, or of the agents which go to make these forces, it is only one, though one of the most important. Nutrition must be attended to. Without perfect nutrition the best muscular force is impossible. If nutrition is faulty, muscular exercise if long continued does harm rather than good. Next in importance to nutrition is a fresh supply of oxygen to make good, pure blood. Exercise should be taken in the open air, or at least in the purest air possible. The skin should not be neglected. In fact, all the laws of hygiene should be observed. Tests and measurements

should be made of every person, to determine the best kind of exercise for that particular person. And these examinations ought to be made by a thoroughly educated physician. It will not do to trust such an important agent in education as physical culture to a man or woman who has only a smattering of knowledge.

Systems of exercise are not half as important as the person who exercises. Systems are only important in what they can do for that person. The systems studied apart from the individual may be perfect. Applied without judgment to particular individuals they may prove disastrous failures. The persons exercising must be studied first, last, and all the time; next, their environment; and then the kinds of exercise suited to their condition and needs.

APPARATUS FOR EXTINGUISHING FIRES.

By JOHN G. MORSE.

DEVELOPMENT OF AMERICAN INDUSTRIES SINCE COLUMBUS. XIX.

A PECULIARITY common to all nations is the fact that not until the industries of peace and the armaments of war had been well developed was attention paid to procuring safeguards against conflagrations; and when it was at last realized that means for the extinguishing of fire were necessary, so little was attempted that the results were entirely inadequate. Even in the United States, noted the world over for advanced methods of fire-fighting, the marked improvements have been so long in coming that half the men alive to-day can remember the time when the most marked changes were made.

It is believed that the first hose used for the extinguishing of fire was made from the gut of an ox. This was attached to a bag filled with water, which, being pressed, would force out a jet. Charles F. T. Young, C. E., the author of Fires, Fire Engines, and Fire Brigades, considers it probable that some mechanical devices capable of squirting water existed in Nineveh, Tyre, Babylon, etc. Ctesibius, of Alexandria, who flourished in the second century B. C. during the time of Ptolemy, is said to have invented a fire engine. Philadelphus and Euergetes are also said to have worked in the same direction.

Certain it is that Hero in 150 B. C. invented and had made a fire engine that was provided with an air chamber, and therefore played a continuous stream. During the darkness of the middle ages fire engines seem to have been forgotten, and it is doubtful if syringes were kept in use. The Chronicles of Augsburg,

1518, speak of "water syringes useful at fires," and from that time onward mention is made of fire engines in Denmark, Germany, Holland, France, and Great Britain. From the work above referred to it is stated that Decaus, in his Forcible Movements, published in 1615, describes a German engine of that period in the following quaint language:

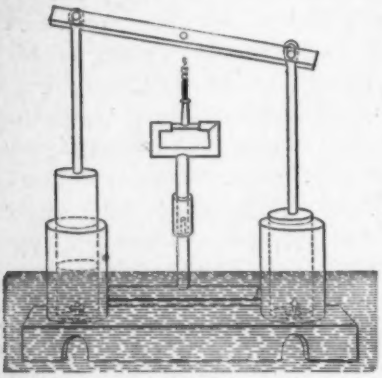


FIG. 1.—HERO'S FIRE ENGINE, 150 B. C. (From Knight's Mechanical Dictionary, by permission of the publishers.)

"A rare and necessary engin, by which you may give a greate reliefe to houses that are on fire. This engin is much practiced in Germany, and it hath been seen what great and ready help it may bring: for although the fire be 40 foot high, the said engin shall there cast its water by help of four or five men lifting up and putting down a long handle, in form of a lever, where the handle of the pump is fastened. The said pump is easily understood: there are two suckers (valves) within it, one below to open when the handle is lifted up, and to shut when it is put down, and another to open to let out the water; and at the end of the said engin there is a man which holds the copper pipe, turning it to and again to the place where the fire shall be."

In 1632 there was a patent granted in England to one Thomas Grant for a fire engine. Caspar Schott, of Nuremberg, manufactured one in 1657 that, when worked by twenty-eight men, would play a stream eighty feet in length. In 1663 John Van der Hayden, of Amsterdam, patented another, and to him is given the credit of bringing the machine to the modern form of hand engine. Several other early engines are mentioned in different works on the subject; among them the "*pompe portative*," patented in France by Duperrier in 1699. To this Perrault added the air chamber.

Although many different engines had been invented, buckets and syringes were in use in England and on the Continent until far into the seventeenth century. The largest of the hand syringes were of brass, and held no more than a gallon. Two men were required with each, one to hold the syringe and the other to direct the stream. In the sixteenth century larger ones were made and placed on wheels. These were capable of holding about a barrel of water and had no hose. The direction of the stream, or, more properly speaking, of the series of squirts, could be changed up and down, as the syringe rested on pivots. To

change the direction from side to side, the entire machine, wheels and all, had to be moved.

Barring the gut of an ox mentioned at the beginning of this article, hose was not known until 1672. Mr. C. R. Robinson, in an address before the National Association of Fire Engineers, states that fire hose was invented by John and Nicholas Van-der-Heide (spelled by some Heyden) in 1672. These brothers were the inspectors of fire apparatus in the city of Amsterdam, and were probably led to make the invention by their experience in these matters. The hose was made of leather, of sail cloth, or of seamless fabric, in fifty-foot lengths, and coupled together with brass screws. This contradicts the popular impression that canvas hose was an exclusively modern invention. Although the leather hose made at that time was very defective, being sewed like a boot leg, it soon supplanted the sail-cloth and woven hose that became worn out so quickly, and up to a very recent date leather has been the only substance used in making hose.

The early settlers in America paid no attention toward protecting themselves against fire, and the different colonies had grown into fair-sized communities with several industries well established before any steps were taken in that direction. About the earliest mention of a definite method of fire protection was made at Salem, Mass., in 1644, when each inhabitant was ordered to be supplied with a ladder under penalty of a fine of five shillings. These ladders were undoubtedly made in Salem or in the immediate vicinity, and one might rightly say that here began an American industry that is now carried on so extensively in many places and under a multitude of different forms. In 1648 four fire wardens were appointed in New York city. These men passed a law to fine every one whose chimney became foul or whose house was burned by his own carelessness. The money so obtained was to be used in the purchase of ladders, hooks, and buckets. These were not provided, however, until some years later.

Boston also took steps in this direction, and on the first day of the twelfth month of 1653, or, by the modern method of computation, on February 1, 1654, the following entry is found in the town records:

"The select men have power and liberty hereby to agree with Joseph Jynks for Ingins to Carry water in Case of fire, if they see Cause soe to doe." Mr. James R. Newhall, in his history of Lynn, Mass., gives the following facts about this maker of fire engines: Joseph Jenks, or Jynks, came from Hammersmith, England, to Lynn as an operative in the iron works. He soon made himself known to the community and to the country at large by his ingenious inventions. In regard to the order

found in the town records of Boston, Mr. Newhall makes the following comment:

"This order, it will be observed, is permissive rather than imperative; and there has been a question whether they did contract for an engine, or, if they did, whether the contract was ever fulfilled, for it is asserted that Boston had no engine till after the great fire in November, 1676, at which time some forty-six dwellings were destroyed, besides shops, warehouses, and 'a meeting house of considerable bigness.' An opportune rain is mentioned as having done much toward arresting the flames, and some buildings were blown up. But nothing is said about an engine being there. Pemberton seems to have thought that as late as 1711 Boston had no fire engine. Yet on the 9th of March, 1702, the town voted that the selectmen should 'procure two water engines suitable for the extinguishing of fire, either by sending for them to England, or otherwise to provide them.' This must have been in addition to one before had, for it was on the same day voted that 'the Selectmen are desired to get the Water Engine for the quenching of fire repaired, as also the house for keeping the same in.' Now, might not the one referred to as needing repairs in 1702 have been manufactured by Mr. Jenks, on the order of 1654? It would have been an old 'machine,' to be sure, but was, no doubt, constructed in a thorough manner, and not very frequently called into use."

Mr. Caleb H. Snow, in his history of Boston, published in 1828, doubts if the engine ordered in 1654 was ever made. He states, however, that in 1679 a fire engine is mentioned as having lately come from England. If this be true, there is a bare possibility that this is the engine referred to as needing repairs in 1702.

It seems extremely doubtful whether a fire engine was manufactured for Boston as early as 1654. The town was then but twenty-four years old, and what money was not used in keeping the wolf from the door was probably fully expended in the meager village improvements and in paying men to repel the continually obnoxious Indians. The inhabitants would hardly have cared to go to the expense of buying a doubtful invention for the extinguishment of the then rarely occurring fires. Nevertheless, Mr. Jenks, from what we know of his mechanical genius, was probably fully capable of making a successful fire engine, had any of the towns in the widely separated and struggling colonies cared to buy one. Had this engine been built, it would not only have been the first made in this country, but it would have been the first one *used* here, many English engines being introduced later. But, as will be seen later, without taking this engine into consideration, Boston holds priority in the ownership of a fire engine. Besides authorizing the purchase of an engine

in this first order of 1654, it was ordered that every house be provided with a ladder and a twelve-foot pole to reach the ridge-pole. Six good and long ladders were to be furnished by the selectmen.

In 1657 New York had made some ladders and hooks. It was also decided to order two hundred and fifty leather buckets from Holland. Thinking it would take too long to have the order filled, it was decided to have one hundred and fifty buckets made in this country. Remout Remoutzen was ordered to make one hundred and Adrian Van Lair to make fifty. These were to cost six guilders two stuyners each (about two dollars and a half). The buckets were finished in 1659, and properly distributed.

Undoubtedly the first fire company organized in this country was formed in New York in 1658. It was called the Prowlers, and was composed of eight men with two hundred and fifty buckets, hooks, and small ladders. Where the buckets were obtained, and whether or not they were in addition to those owned by the town, the records fail to state. In 1679 Salem purchased two or three dozen cedar buckets, besides hooks and other implements; also, the selectmen and two others were authorized to take command at fires, and to blow up and pull down buildings when such action was necessary. This practice appears to have been much more common before the use of engines than afterward. Boston, on September 9, 1679, ordered that every quarter of the town should be provided with twenty swobes, two scoopes, and six axes. The swobes, or swabs as they are now called, were long-handled mops that could be used to put out roof fires. The general use of swabs has long since disappeared, but when a slight blaze is beyond the reach of a pail of water and more improved apparatus is not at hand, a long-handled mop is to-day the most efficient article to be used. In Japan these swabs may be seen on many roof tops.

In 1690 New York ordered that five ladders and also hooks be made. In Philadelphia no mention is made of public precaution against fire until 1696, when a law was passed forbidding the firing of chimneys or allowing the same to become foul. Each house was to have a swab, bucket, or pail. Another act was passed in 1700, ordering every household to have two leather buckets. In the following year six or eight hooks for the purpose of tearing down houses were ordered to be made.

As has been stated above, Boston bought two engines in England in 1702, and therefore, if the engines of ~~1751~~ and 1679 never existed, Boston was yet the first town to be the proud owner of a fire engine. Philadelphia came next, in ~~1718.~~ On December 8th of that year the Council agreed with one Abraham Bickley for "his ffire Engine At ye sum of £50." This engine had been imported from London by the said Bickley.

1654

1718

With the exception of the buckets made in New York in 1657–'59 by Remout Remoutzen and Adrian Van Lair, no mention is made of the makers of the different equipments provided. In 1729 Salem again took steps toward protection from fire by ordering buckets, hooks, poles and ladders to be kept in the Town

FIG. 2.—EARLY FIRE FIGHTING. (From an old print.)

House, but the records fail to state where and by whom the buckets, etc., were made. It is most probable, however, that the ladders, hooks, poles, and swabs were made by artisans in the different towns, but many of the buckets were undoubtedly manufactured in Europe. Later records are more specific. In 1730, Philadelphia, besides buying some buckets in England, made a bargain with a townsman, Thomas Oldman, for one hundred leather buckets.

New York had no fire engine until 1731, when two were bought of Mr. Newsham, the celebrated London maker. These engines were box affairs, with small wheels and axles solidly set. They could not turn corners, but had to be lifted bodily around. The first engine of home manufacture was built in New York in 1737. In the New York Gazette, of May 9th of that year, the following advertisement appeared:

"A Fire-engine that will deliver two hogsheads of water in a minute, in a continual stream, is to be sold by William Lindsay, the maker thereof. Enquire at Fighting Cocks, next door to the Exchange Coffee-house, New York."

Whether or not this engine was successful is unknown, but it

is tolerably certain that it was never used. Bartholomew Weldern also made two engines, neither of which would work. In the same year, however, Thomas Lote made an engine that was more successful. It was used in the New York department, and known as number three. Considering the length of time between 1654 and 1737, in which no mention is made of home-made engines, it seems still more doubtful if Mr. Jenks, of Lynn, did make the first machine in this country, and undoubtedly priority should be given to one of the several New-Yorkers just mentioned.

Benjamin Franklin states in his autobiography that his reading a paper on fire protection before a Philadelphia society gave rise to the forming of "a company for the ready extinguishing of fires, and mutual assistance in removing and securing of goods when in danger." Besides the usual buckets, each member carried a bag made of four yards of osnaburgs or wider linen, with a running cord at the neck. These bags were used in safely transporting valuables and small articles from burning buildings, and

FIG. 3.—EARLY FIRE FIGHTING. (From a certificate issued to Seth Kneeland, New York Volunteer Fire Department, November 13, 1789.)

formed a primitive forerunner of the outfits of the protective patrols of to-day. Franklin was a member of the company thus started.

Jacob Turk, who became the head of the New York department in 1739, introduced the style of leather hat that is worn by firemen at the present day. Despite the countless changes that have taken place in apparatus of all kinds, the fireman's hat remains practically unchanged, and serves, as it always has, for a distinguishing emblem to the profession.

Massachusetts passed a law in 1744 empowering all towns to choose fire wards. The wards were to have for a distinguishing

badge of office a staff five feet long, painted red, and headed with a bright brass spire six inches in length. One of the first towns to take advantage of this law was Salem. At the same time a fire club was formed that purchased a fire engine in England in 1749 and another in 1751.

Baltimore first took precautions against fire in 1747, when the housekeepers were ordered to have ladders in readiness. The Annals of Providence tell us that measures in this direction were not taken until 1754, when a law was passed compelling each housekeeper to have two buckets. An engine was also purchased, although the records fail to state where it was manufactured. Another engine was bought in Boston in 1760, undoubtedly a second-hand English machine, as at that time there were no makers in Boston.

It will be noticed that, although engines had been made in this country, foreign machines were preferred, probably on account of

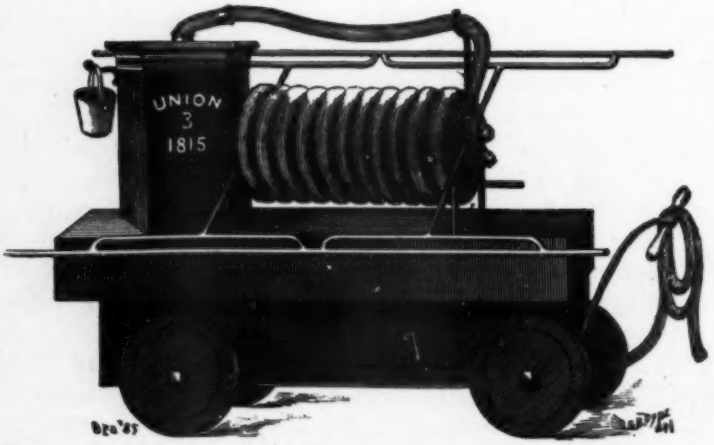


FIG. 4.—EARLY "HAND TUB." (From a Sketch and Reminiscences of the Providence Fire Department.)

their superior workmanship. The foreign makers, however, were soon to lose their precedence. Mr. A. W. Brayley, in his History of the Boston Fire Department, states that in 1765 David Wheeler, an ex-fireman of Boston Engine Company 8, manufactured the first complete fire engine ever made in that town. Wheeler was a blacksmith established on Washington Street, then called Newbury. He gave notice to the press that he would encourage home industry by making a fire engine. This he did, and on August 21st the same year he had a chance to try his production, which worked to the satisfaction of all present. In 1767 Wheeler asked permission to make another. This was granted, and the same year the importation of engines

from abroad was prohibited. An industry was not only started but encouraged by law—one that has increased and spread in all parts of the country, embracing the manufacture of more improved apparatus at a later day, until now it is the greatest industry of its kind in the world.

Although begun in New York and Boston, the making of fire engines was soon established in Philadelphia, where for over a century it flourished to a greater extent than in any other city in the country. From the history of that city by Messrs. Scharf and Westcott, we learn that in 1768 Richard Mason, on Second Street, began the manufacture of fire engines. His quaint advertisement appears in a copy of the Massachusetts Centinel of Saturday, November 7, 1789, published in Boston:

"Fire Engines made on the newest and most approved construction; warranted for seven years, and sold as cheap as they can be procured from Europe. The business is now extensively carried on in all its various branches, by the subscriber, in Union Street, Philadelphia; where Engines of any size may be had; and towns and fire companies supplied therewith on the shortest notice." After mentioning small engines for house, garden, and ship use, the advertisement goes on to state:

"He has several good second-hand engines for sale, at low rates:—and makes fire-buckets of the neatest and best sort, which he supplies, handsomely painted with any device required, at a short notice.

"The strictest attention paid to orders from any part of the continent, or elsewhere; and the utmost punctuality and dispatch may be relied on."

A list is given of the five sizes made, varying from one of eighty gallons, throwing water eighty feet and worked by six men, to one of one hundred and seventy-five gallons, throwing one hundred and seventy-five feet and worked by eighteen men. The prices varied from £40 to £120. The advertisement closes as follows:

"N. B.—The main body of water will not be thrown to the above distances, and a greater number of men may be applied to the large engines if occasions should require."

Mr. Mason was the first one to place the levers upon the ends instead of upon the sides of the engines, and thereafter they were spoken of as the Philadelphia levers.

The first ladder companies possessing trucks on which to carry their ladders and hooks were formed in New York in 1772, and were numbered one and two. There had been two trucks in the New York department previous to this, carrying no name or number. These were probably the first pieces of apparatus of this kind used in the United States, for a careful scrutiny of different records fails to show an earlier one.

In 1774 each engine in Salem—there were then three—was furnished with a framed canvas screen in three or four leaves, eight feet high. The canvas was kept wet by the use of long-handled swabs, and the screens are said to have been of great service in preventing the spread of fire. Screens of this kind were used in Salem and the adjoining towns until a very late day but they were evidently local in their character, for the records of the departments in other parts of the country do not mention anything of like nature.

At the close of the Revolutionary War in 1782 the manufacture of fire engines that had been established in Philadelphia took a decided start, and soon became such a distinctive feature among the industries of that town that it added greatly to its notoriety. Boston also for some time took a prominent part in this industry. In 1792 the firm of Hunneman & Company, manufacturers of hand fire engines, was established. This firm continued to make hand fire engines until the introduction of steamers threatened to ruin its business, and to save itself it embraced the manufacture of steam fire engines. After continuing to bear the name of Hunneman for almost a century it passed into different hands and the firm is still in existence. As far as can be ascertained, this is the oldest concern of the kind in this country and perhaps in the world.

When Hunneman & Company first established their works the New York authorities decided to make their own engines, and did so to some extent, but also continued to buy elsewhere, the records showing that one was purchased from Philadelphia in 1798. The Philadelphia engines traveled farther from home than to New York. In 1797 Salem, having bought several in England during the previous years, ordered one from a Philadelphia maker by the name of Samuel Briggs. The journey to Salem so injured the machine that it was useless on its arrival, and the maker had to send on an agent to superintend its repair.

The history of the Boston Fire Department states that in 1798 a Mr. Fenno, of that town, made some new hose for engine five. This seems to be the first mention of the making of fire hose in this country. Although the Boston authorities had prohibited the importation of foreign engines, they did not put the same restrictions upon hose. In the same year they purchased two hundred feet of hemp hose from Holland, giving as their reason for so doing that the English and American kinds were unsatisfactory.

The New York firemen saw at an early date the need of something more effectual than land engines with which to fight fires on the water front. Somewhere between 1805 and 1810 a large boat, rowed by twenty-four men, and provided with a fire engine,

was put in service. It did good work, but in winter the hardships of the men were so great that few would serve, and the boat was abandoned. This was a forerunner of the fire boats with which so many of the larger cities are now provided.

Messrs. A. L. Pennock and James Sellers, of Philadelphia, in 1818 invented and manufactured the first leather copper-riveted hose used in this country. Burr and Shaw, of Providence, established a similar business a few years later.

Boston had no ladder truck until 1820. Having provided many new ladders and hooks, the authorities purchased a rather worn-out express wagon upon which the articles mentioned could be carried to fires more readily. A company was formed to man the same.

During the early part of the century the departments of the larger towns realized that the private pumps and wells did not form a sufficient water supply, and town pumps and cisterns were placed at convenient intervals about the streets. Instead of filling the engines by means of lines of bucket-passers, it was often possible to pump directly into the machine. This led to pumping direct from the stationary pumps into the fire hose when the pumps were in close proximity to the fire, and soon hose companies were formed. A famous company of this kind was formed in Providence. Equipped with a hose carriage and one thousand feet of hose, its members competed for honors with the finest engine companies. This was one of the first hose carriages used. The leading hose of the engines had always been carried on the machines, and this custom was generally continued. Mr. George W. Sheldon, in his history of the New York Volunteer Firemen, states that David J. Hubbs, foreman of one of the companies. introduced the first separate hose carriage in the New York department. It was a very simple device, a reel on the axle between two ordinary wheels. This was known as "Hubbs's Baby." It was either tied behind the engine or pulled by two of the members of the company.

Up to the year 1820 the fire apparatus in use had improved but little. The larger towns only were provided with engines, and, as has been stated, these were box affairs that were filled by lines of bucket-passers or by stationary pumps. The brakes and pumps, it is true, had been greatly improved, and, indeed, besides the piston-pump engines worked by brakes there was a rotary pump in use, driven by a crank and geared to greater speed by cog wheels, but the engines were limited in their usefulness by the unsatisfactory method employed in supplying them with water. Somewhere between 1819 and 1822, although the exact date is in question, a new era was begun in the method of fighting fire.

The Hon. Elisha Dyer, in a paper devoted to the Providence Fire Department, states that the first successful suction engine made in the United States was manufactured by Sellers & Pennock, of Philadelphia, in 1822, for the town of Providence. It was named Hydraulion No. 1. At about this date all the engines of the New York department were provided with suctions. Proba-

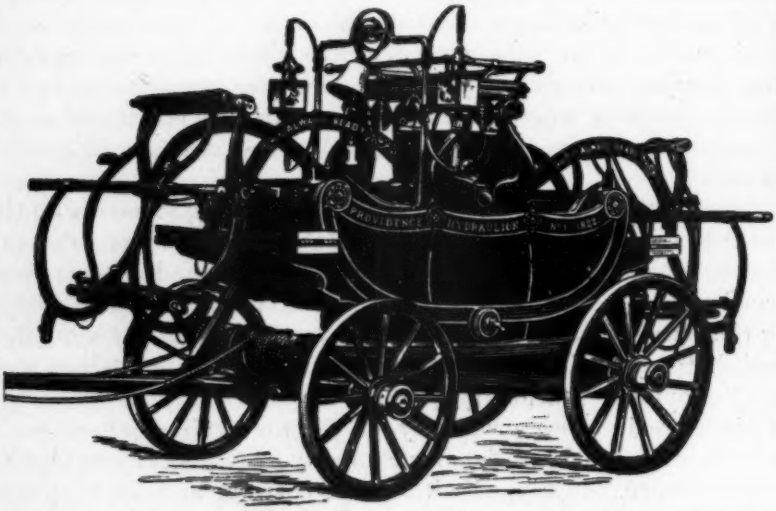


FIG. 5.—FIRST SUCTION HAND ENGINE. (From a Sketch and Reminiscences of the Providence Fire Department.)

bly at that time many of the old engines, in different parts of the country, were changed to suction engines, while the first new one built was Hydraulion No. 1, of Providence. With the introduction of suctions the general efficiency of the engines was greatly increased. Every pond, brook, and bucketless well was at the service of the firemen, and a new impetus was given to the manufacture of fire apparatus.

In 1834, Button & Company, of Waterford, New York, entered the field. They continued building hand engines until the introduction of steam, when they followed the example of Hunneman & Company, of Boston, and began the building of steam engines. Their successors lately consolidated with the American Fire Engine Company, who, as the successors of Hunneman & Company have discontinued the manufacture of fire engines, now form the oldest house of the kind in the country. The Button hand engines are still placed upon the market for the use of small country departments.

In 1848, William Jeffers, of Pawtucket, Rhode Island, in connection with two or three other mechanics, altered over the pumps of a hand engine. He met with such good success that

he began the manufacture of hand engines, and in 1861 added the making of steam fire engines to his business. Crockett, E. B. Juckett, Henry Waterman, Pake & Kells, John R. Adams, John Agnew, and several others were well-known names connected with the building of hand fire engines, but it is difficult to obtain the dates at which they entered the field. Many of them made steam engines at a later date.

It is hard to realize that at the end of the first half of the nineteenth century the fire departments of this country were still far behind the times both in organization and in apparatus. Steam railroads were pushing out in every direction, steam vessels were crossing the ocean, steam power was being used in countless mills, the electric telegraph had been invented, the equipments of the army and navy were being continually improved, and machinery was taking the place of hand work in every kind of manufactory. The firemen, on the other hand, were using manual engines drawn by hand, small and inadequate ladder trucks and hose reels, also dragged to fires by the firemen themselves. Their apparatus was removed but a few steps

FIG. 6.—ERICSSON'S ENGINE. (From Scribner's Magazine, by permission of the publishers.)

from the old squirting syringes. The men were brave, but did their work of their own free will. After the city government had paid for the engines the firemen assumed all other expenses. It is not the purpose of this article to discuss the organization of the volunteer fire departments, but simply to show how handicapped they were by apparatus that was out of date, and entirely unfit to cope with the fires that were sure to occur in the inflammable and rapidly growing cities.

The year 1840 marks the beginning of a great era in the development of fire apparatus, although the stupidity of the general public prevented the adoption of the improved methods for several years later. Stationary steam pumps had been used in mills for some years previous to 1842, but up to that time a portable steam fire engine was a thing unknown in this country. In 1830 Captain Ericsson, then of London, but later famed as the builder of the Monitor, designed a steam fire engine, and the firm of Braithwaite & Ericsson built one machine and operated it in London entirely at their own expense in the hopes that more might be introduced. They met with so much opposition, however, not only from the press but forcible interference from the firemen, that they abandoned the attempt. The Prussian Government in 1832 ordered a steam fire engine built that threw a single stream one inch and a half in diameter.

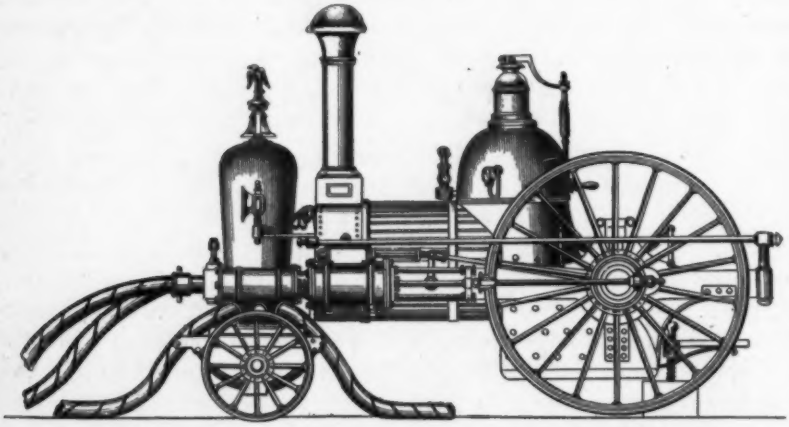


FIG. 7.—FIRST STEAM FIRE ENGINE IN THE UNITED STATES, 1840.

After his failure in London Captain Ericsson thought he would try again with the more progressive Americans, but he was doomed to disappointment. Designs that he made for an engine were awarded a prize by the American Institute in 1840, but no machine was built. The first steam fire engine ever built or used in the United States was one made by Mr. Paul R. Hodge for the Matteawan Insurance Company, of New York. The engine was a self-propeller, and when working at a fire was blocked up so that its hind wheels might be used as balance wheels. When housed it was connected with boilers, and fuel was always laid that steam might be got up quickly. This engine was operated at the expense of the insurance company, but continually met with opposition from the volunteer firemen. Finally, when playing at a fire in Dover Street, the machine did such excellent work that the firemen utterly refused to allow it to be used thereafter,

and it was stored away, and New York's fire protection was limited again to the old hand tubs.

Such a marked improvement as a steam fire engine, however, could not long remain unadopted by the progressive people of this country, even though their protectors, the volunteer firemen, insisted that hand power was the only means that should be used. In 1852 Messrs. Latta & Shawk, of Cincinnati, placed a steam boiler and cylinder in connection with the pumps of a hand engine belonging to the Cincinnati department and mounted the whole contrivance on wheels and frame. A public trial was made of this crude affair, and it worked very successfully. In the short time of four minutes and ten seconds steam was raised from cold water, the engine started, and water discharged through three hundred and fifty feet of hose to a distance of one hundred and thirty feet from the nozzle. Although this exhibition was naturally looked upon with dislike by the volunteer firemen, the city government was greatly pleased and immediately contracted with the makers for a complete steam fire engine. This was built and put in service with a company organized and supported by the city. Thus the first paid fire company in the world to operate by steam power was brought into existence.

The volunteers made great opposition to the change in affairs, but the chief engineer of the paid department, Miles Greenwood, was so energetic and persevering that with the help of other level-headed men the opposition was overcome and the trouble adjusted. To Mr. Greenwood is due much of the credit for introducing the steam fire engine into this country. The firm of Latta & Shawk passed into different hands, until controlled by the celebrated Ahrens Manufacturing Company, which in turn has been absorbed by the American Fire Engine Company.

The fame of the Cincinnati engines spread, and other cities endeavored to introduce the system, always meeting with the most violent opposition from the volunteers. The press, however, advocated the change, and called for its universal introduction. A Boston gentleman, having visited Cincinnati, wrote in the Boston Transcript of August 7, 1857, that he was amazed at the efficiency of the Cincinnati department, and believed it had demonstrated the impossibility of extensive conflagrations. He was disgusted to return to Boston and find men and boys dragging hand tubs to fires, after having discarded a steam fire engine without giving it a fair trial. But the steam fire engine was bound to come. Chicago and other western cities closely followed Cincinnati by organizing paid departments equipped with steam engines. The more intelligent volunteers in the east began to see the error of their ways, and replaced their hand engines with the more modern apparatus. Boston was the first of the eastern cities to organize

a paid department, which she did in 1860. New York did the same in 1865, and Philadelphia in 1871. Other eastern cities rapidly fell into line, but some of the southern cities, though equipped with the most modern apparatus, continue to the present day with volunteer firemen, New Orleans having only recently adopted a paid force.

When the success of the steam fire engine became an established fact the demand increased rapidly. Not only did many of the hand-engine builders begin their manufacture, but almost all the locomotive works and many machine shops did the same. Also many new firms sprang up. In almost every eastern and in many western States men went into the business, while in some cases the volunteer companies, notably one in Pittsburg, had the steamers built under their own supervision at the shop of one of the members. Philadelphia kept up her long-standing reputation by soon having ten or more competitive firms engaged in the work. Some of these numerous makers built but one engine, some of them only a few, while others continued in the business for several years.

The Portland Company Locomotive Works, of Portland, Me., made steam fire engines from 1859 until 1870. At the time their engines had the most powerful suctions of any in the market, and one of them, that is still on duty in Bangor, ably keeps up its reputation in this respect. The work was discontinued because the complicated nature of the machinery rendered it impossible to set a competitive price. In 1858 Thomas Scott and N. S. Bean, of Lawrence, Mass., made an engine for the Boston department. The business thus established was absorbed by the Amoskeag Manufacturing Company, of Manchester, N. H., and their engines are now built by the Manchester Locomotive Works.

Silsby, Mynderse & Company, of Seneca Falls, and Clapp & Jones, of Hudson, N. Y., were extensive builders, and their successors have combined with the successors of the Button Company and the Ahrens into the American Fire Engine Company. The multitude of firms in the eastern and a few in the western States that went into the business are too numerous to mention, and most of them soon discontinued the making of engines. The Philadelphia firms one by one dropped out, and that city's reputation in this line is a thing of the past. Ettenger & Edmund, of Richmond, made in 1860 an engine for St. Petersburg, Russia. This was one of the first American engines sent abroad.

These early machines were of all models and sizes, either large and cumbersome self-propellers or small and light to be drawn by men. Engines drawn by horses were not generally introduced until some years later. The different makers evidently made experiments to find the most satisfactory arrangement of the ma-

chinery. Some had the boiler at the extreme back, and the pumps and air chamber in the middle; in others the air chamber was far in front, while one builder put the air chamber and pumps behind, with the boiler in the center. Occasionally the self-propellers were three-wheeled affairs, while others on four wheels carried such an amount of chain and gears that they could hardly move their own ponderous weight. A comparison of pictures of the early machines would, to the most careless observer, show a marked difference in form, while the engines of the present day are nearly alike in general appearance.

The La France Fire Engine Company, Elmira, N. Y., and the Waterous Engine Works Company of St. Paul, have made engines but a comparatively few years, and with the Manchester Locomotive Works and the American Fire Engine Company are the only firms in the business to-day. Some few cities, notably

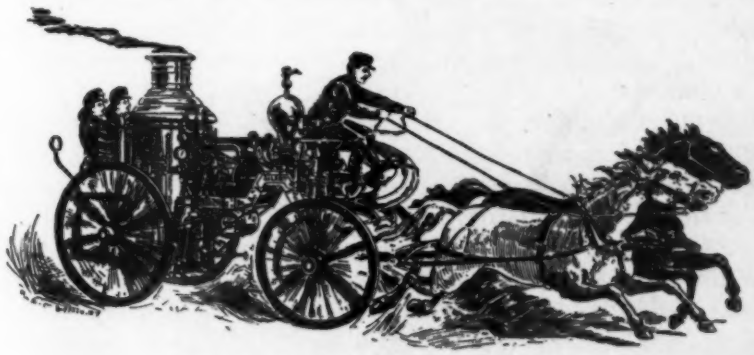


FIG. 8.—STEAM FIRE ENGINE OF TO-DAY.

Cleveland, encourage home industry by occasionally having engines built by local machinists.

It is not within the scope of this article to go into a technical description of the boilers, engines, and pumps used in the different styles of steamers made to-day. Each maker has endeavored to provide a boiler so arranged that steam can be generated in the shortest possible time. The engines must be light and capable of being worked in positions often far from level. The pumps must be powerful both in suction and in being able to throw streams to great distances. At the same time they must be as simple as possible and not easily clogged, for often the only available water is in some muddy pool or pond filled with foreign matter. When it is remembered that fire engines are often bought by village departments where there is no one of mechanical ability to care for them, it will be evident that every part of the machine must be of a quality and construction that will stand misuse and abuse.

The Amoskeag, Ahrens, Clapp & Jones, Button, and Water-

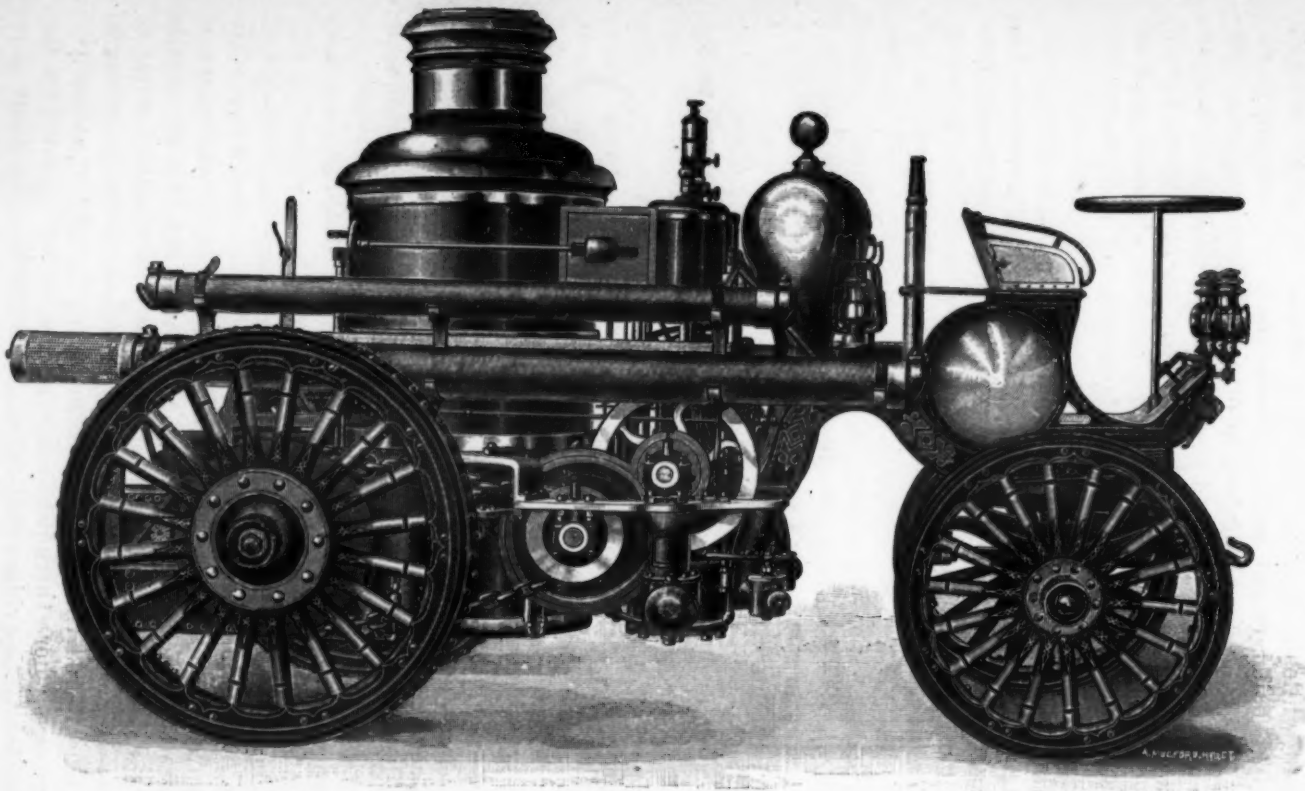


Fig. 9.—Self-propelling Steam Fire Engine.

ous engines have piston pumps; the Silsby engines have rotary pumps, and the La France Engine Company manufactures two distinct styles of engines—one with a piston pump and one with a rotary. The piston pump needs no description here, but it will be well to say a few words in regard to the rotary pump. The engine in this case is composed of two cams, which to the uninitiated are irregular cog-wheels with alternating large and small cogs, working in a steam-tight case. The steam entering from one direction forces these cams to revolve with great rapidity. The pump is composed of cams somewhat similar, which are connected with the engine cams, and when revolving suck the water and force it through the discharge pipe with great pressure. The capacities of steam fire engines differ from three hundred gallons per minute in the smallest sizes up to twelve and thirteen hundred gallons per minute in the largest.

Self-propellers are very little used at the present day. Boston, Providence, Hartford, New York, Brooklyn, Detroit, Chicago, Milwaukee, and other cities, have all tried them, but they have been very generally discarded for engines drawn by horses. Hartford is a notable exception to the list, there being two self-propellers in her department. The latest of these is an Amoskeag engine by the name of Jumbo, and has a capacity of thirteen hundred and fifty gallons per minute. This is probably the largest land fire engine in the world. The city departments are always furnished with the larger sizes of engines drawn by horses, but in many towns engines of lighter draft, that can be drawn by men, are often used. Crane-neck and straight frames are both used, but the former are more common. The American Fire Engine Company make a combination engine and hose wagon called the Columbian engine. The wagon part is forward, and the engine and boiler are over the rear wheels. This is very convenient in suburban departments, as it reduces the number of pieces of apparatus. The fire-engine makers of the United States supply the home market exclusively, and a number of machines have been sent to Canada and to foreign countries.

The most powerful allies of the land engines are fire boats, that are now used by all large cities bordering on the water. The capacity of a fire boat is often equal to that of ten to twenty land engines, and is limited only by the size of a boat that can be worked quickly and easily among the crowded shipping of a harbor. As has been seen, New York had a floating hand fire engine in use during the early part of this century, but it was not in service for any length of time. After steam vessels came into general use, harbor tugs were often provided with fire pumps, that they might aid in extinguishing fires on the water fronts. The first boat built expressly for fighting fire was launched in 1872,

from the Atlantic Works, East Boston, for the Boston Fire Department. Her pumps were of the Amoskeag pattern. This boat has since been replaced by one more powerful. The next fire boat was the Havemeyer, built in New York in 1875, and followed in 1883 by the Zophar Mills for the same department. These boats are still in service.

The first very powerful fire boat was the Seth Low, built for the Brooklyn department by the Cowles Engineering Company of that city. This company has since built a number of fire boats

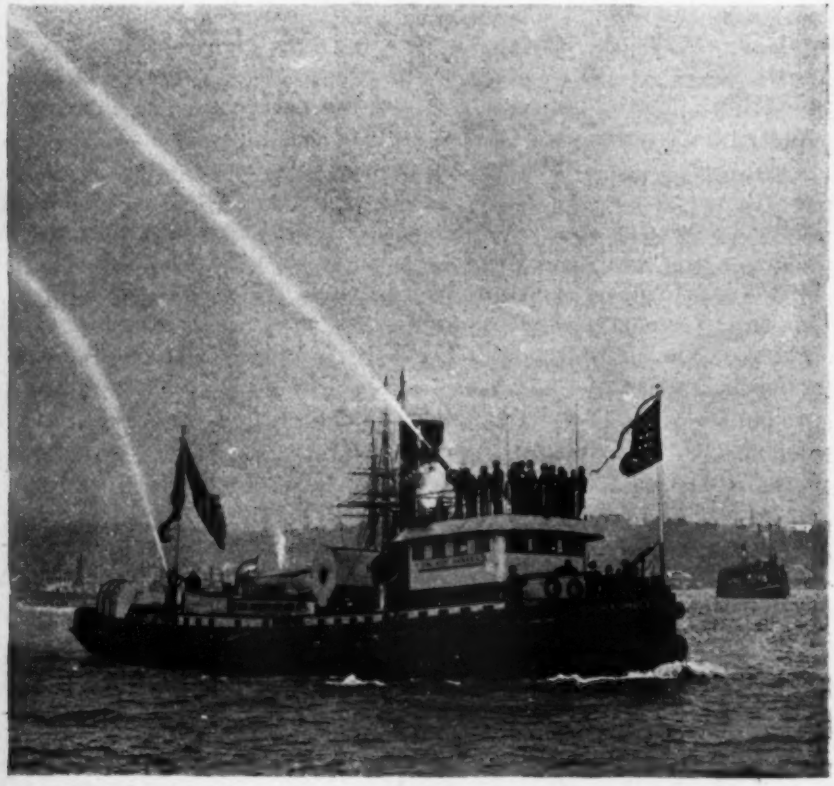


FIG. 10.—THE FIRE BOAT NEW-YORKER, NEW YORK FIRE DEPARTMENT.

for different cities, one of them being the New-Yorker, which is among the most powerful in the world. Chicago has four fire boats in her department. The modern fire boat is sometimes built of wood, but generally of iron, and in some cases the decks are so provided with corrugated iron shields and sprinklers that the boat can be worked to advantage in a perfect sea of fire. The whole power of the pumps can be concentrated in one stream from three to five inches in diameter, from a swivel nozzle on the forward deck, or, instead, a large number of ordinary fire streams can be

played at once. When using the one powerful stream at the bow a brick wall can be penetrated, and the fire is not only deluged, but the force of the stream knocks the flaming timbers to pieces, and so distributes the fire that it can be quenched more rapidly. When playing a multitude of smaller streams the fire boat can go between a warehouse and a group of vessels, no matter how furious the fire may be, and there obtain a point of vantage impossible to a land engine. It is stated that the New-Yorker could sink herself in fifty seconds. The crew live in a house on the wharf where the boat is stationed, and can reach their places as rapidly as the members of a land fire company can reach their engines. Fires are kept banked at all hours, and every alarm within reach of the water front is answered. It will not be out of place to quote a passage from an article on Modern Fire Apparatus in Scribner's of January, 1891:

"It is not uninteresting to note that there are floating fire engines in London. They consist of steam pumps placed on scows which are moored at long intervals along the water front. When an alarm of fire comes in, the captain of the scow goes whooping up and down the water front to get a tug to tow him to the place from which the alarm has come!"

Many cities increase the possibilities of fire boats by laying empty pipe lines from the water front inland. The fire boat can couple on the line nearest the fire and the land engines can draw from this unlimited water supply in addition to the regular city system. The time is probably not far distant when every town and city bordering navigable water will have one or more fire boats in its department.

Steam locomotives can be made to serve as fire engines by attaching a device made by the Nathan Manufacturing Company of New York. It consists of a pipe placed at a point just below the level of the stationary water tanks in use on the railroad. There are two receiving nozzles in the center and two delivery nozzles at the base. The former are connected with a tank or an ordinary hydrant, and steam entering at the top of the pipe will force one eleven-sixteenths-inch stream one hundred and fifteen feet or two half-inch streams sixty feet. This device can be used very effectively in crowded freight yards where the regular firemen have difficulty in working with promptness, and also at way stations where there is no fire department.

It has long been known that certain chemicals will not support combustion, and during the middle of this century a number of chemists began to devise means by which such chemicals could be used to advantage at fires. The first practical results were five to ten gallon cans filled with a mixture of gas and water. Small hose was attached, through which the fluid could be played.

Fig. 11.—Chemical Fire Engine.

In some instances the combination of gas and water aided greatly to extinguish the fire, while in others the gas escaped into the air and served only to force the water in a stream. The successful inventors soon tried large tanks on two and four wheeled trucks, and to-day all sizes, from tin and glass hand grenades up to large double-tank four-wheeled engines, are in use.

The first chemical engine was put on the market by the New England Fire Extinguisher Company of Northamption, Mass. The Babcock Company of Chicago took this up, and by the aid of one of their engineers, Mr. Wellington Lee, who had previously done much work with steam fire engines, soon made it much more successful.

The Holloway, of Baltimore, the Babcock and Champion, made by the Fire Extinguisher Manufacturing Company of Chicago, and the Hutson and the Lindgren-Mahan, also of Chicago, are the engines in general use at the present day. The chemicals used in these different engines are more or less the same, and the engines themselves consist of one or two tanks placed either horizontally or vertically, and having one or two lines of small hose attached. In some cases small extension ladders are carried. Combination chemical engines and hose wagons or carriages were used in Canada as early as 1883. Springfield, Ohio, Lawrence, Mass., Chicago, and Milwaukee had them in 1886. They have recently been adopted in Boston. The wagon is made deep and narrow, and a chemical tank placed on each side. Combination ladder trucks and chemical engines are also made. The New York department, the largest in the world, has discarded the use of chemical engines, but they are considered necessary adjuncts to most of the other fire departments of the country. Five or ten gallon tank extinguishers, however, are carried on all hose wagons and ladder trucks in New York and elsewhere. The chemical engine can go into action more quickly than a steam fire engine, and will extinguish small blazes with very little water damage. In connection with chemical engines it might be stated that for fires in electrical stations sand is the best extinguisher known. It has been found by experience that the application of water simply complicates matters by crossing currents, increasing the sparking, and ruining the plant.

It has been remarked that the Button hand engines are still made. Country departments, when old city tubs can not be bought, must have new hand engines made for them. The Gleason & Bailey Manufacturing Company, of New York, are extensive builders of these.

Several inventors have tried their hands at producing an electric fire engine, either to have the boiler and fire box of a steamer replaced with storage batteries, or else to have a trolley

connection that could be used on any convenient electric railroad wire. In 1888, or thereabout, Mr. S. S. Wheeler, of New York, designed an electric engine which was constructed by placing a

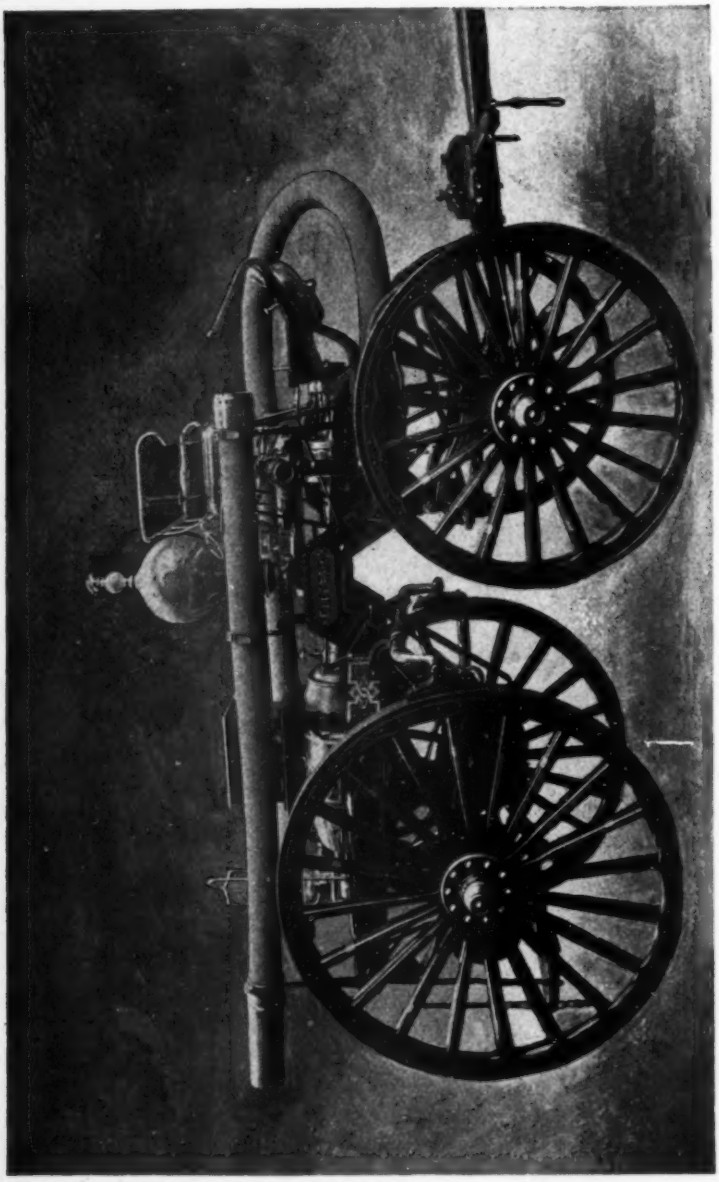


FIG. 12.—ELECTRIC FIRE ENGINE.

Sprague electric motor, directly attached to a Silsby rotary pump, on a Silsby crane-neck steam fire-engine truck. Several hundred feet of insulated wire were carried to be attached to electric connections. This engine is now the property of the Crocker-

Wheeler Electric Company. Mr. Joseph Sachs has also invented an electric engine, which is described in Cassier's Magazine for February, 1895. Undoubtedly in the future some machine of this kind will be introduced, but at present the industry is still in its infancy.

[*To be concluded.*]

THE MOTIVE FOR SCIENTIFIC RESEARCH.

By HUBERT LYMAN CLARK.

AT the meeting of the British Association for the Advancement of Science held at Oxford in August, 1894, the president, the Marquis of Salisbury, delivered a remarkable address on Unsolved Problems of Science, which called forth much criticism, particularly from scientific journals. The speaker called the especial attention of his audience to four great questions which, with all the boasted advances of science, still remain unsolved, and the solution of which seems as far distant to-day as ever. These questions were, the origin of the chemical elements, the problem of the ether, the origin of life, and the theory of evolution. The tendency of the address was certainly not to give encouragement that these problems would soon or even ultimately be cleared up by the work of scientists, but rather indicated a certain satisfaction that there were nuts to crack which even the British Association would find too hard. This tone was especially evident in the treatment of the subject of organic evolution, and the speaker made it plain that he considered certain of the objections to that doctrine conclusive and was ready, for one, to fall back on the doctrine of design to explain all the innumerable variations and adaptations which we see in animal and plant life about us. That the whole address was certainly reactionary there can be no doubt, but it seems to be unfortunately true that certain of the criticisms which it has called forth are to be equally condemned for going at once to the other extreme. In one of the leading scientific magazines of this country the reviewer says, under the heading Back to Dogma:

"It needs but a few moments of careful and candid consideration to show that the doctrine of design means the death of scientific investigation. If things are so because they were intentionally made so or because certain processes were miraculously expedited, then the universe may be the theater of will, but not of forces the operation of which we can hope to understand. . . . The reason why the doctrine of design is so popular is partly because it is such a saver of intellectual toil, and partly because by

making knowledge impossible it glorifies ignorance. What is left for the student of Nature save to record facts as he finds them when every question as to how things have come to be as they are receive but the one reply, 'The Creator designed them so'?"

It is not my intention or wish to defend in itself the doctrine of design, nor is this the place to review the reviewer or criticise the above-quoted criticism; but such uncalled-for prejudice and illogical reasoning as shown therein do cause the question to arise, What, after all, is the real motive for scientific research?

A little over fifty years ago a young Englishman was busily engaged in gathering and arranging all kinds of facts in regard to changes in animals and plants, either under domestication or in a state of Nature. For twenty years or more he worked patiently and carefully gathering his facts, comparing and arranging them and mentally digesting all this mass of material, and, at last, in 1859, he offered to the world his theory of the Origin of Species. Before Charles Darwin, all naturalists were engaged in gathering and recording facts, and arranging them in a more or less natural order, but they failed to compare and digest them, as he did, because they were content with statistics and did not ask for reasons. That this was due to a belief in the immutability of species and the doctrine of design there can be little doubt; but that the great men who accepted that doctrine did so because it "saved intellectual toil" or "glorified ignorance" is a gross slander. They did so partly because of early training, but very largely because it was a satisfactory explanation of such problems as they happened to meet and so proved its sufficiency. When Darwin, however, came to apply it to the facts as he found them in his day, he soon proved it was *not* sufficient, and then was asked for the first time in biology, *How* did these things come to be so? The question had been asked long before in physics, chemistry, and astronomy; but until the middle of this century biologists and even geologists had been chiefly concerned with the question WHAT? and had neglected the far more important one HOW? It was the asking of this question, and the answer to it which he gave, which makes Darwin the bright particular star in the scientific firmament of the nineteenth century, and no lapse of time can ever dim the luster of that honored name. However inadequate we may consider the theory of natural selection to account for all the innumerable forms of animal and plant life which have existed or do now inhabit and beautify the earth, there can be no doubt that the question as an answer to which it was offered has been for thirty-five years the mainspring of research not merely in biology but in all the field of natural science. It is easy to see how this condition

was itself the result of evolution, for one can not ask the means to an end until the end is seen or known. Up to the time of Linnæus there was little general interest in zoölogy and botany, but after he had placed in systematic order such facts as were known to the scientific world of his day, others began to find all about them additional facts which had been theretofore unrecorded, and so interest in Nature began its steady rise toward the high position which it holds to-day. So long as the great majority of forms were unknown or undescribed, the only question was concerning *what* existed, and naturalists everywhere were busy with these facts of the existence of species; but as the records became more complete and the knowledge of natural phenomena wider spread, of course the tendency would naturally be toward inquiry as to *how* these innumerable forms arose. Even as early as the latter part of the eighteenth century some of the deepest thinkers were turning this question over in their minds, although they did not appreciate its great importance or its bearing on the acquisition of knowledge. Darwin himself began his career as a gatherer of facts, but his active mind soon saw the inadequacy of the doctrine of special creations, and demanded something more in accordance with the facts. The history of the development in his own mind of the famous theory to which his name is attached is a most fascinating story, but it is not necessary to enter into any details here. Suffice it to say that he became thoroughly convinced in his own mind, and actually convinced the whole scientific world, even including his most bitter opponents, that the question of the hour was *not* one of which species was which, nor to what family it belonged when identified, but "*How did species arise?*" From that day to this the whole trend of scientific study has been toward the solution of that problem, and an enormous amount of investigation by biologists, far and near, has thrown much light on its intricacies, although, when we consider all phases of the subject, including the difficulties of heredity, we feel that we have hardly made more than a beginning.

This change of position in the subject-matter of scientific research has brought about a most remarkable and far-reaching change in method, which is universally recognized as vastly superior to the old. But it seems also to have brought about an equally radical change in the spirit of investigation; and instead of the reverent work of an Owen, an Agassiz, or a Lyell, who believed they were studying the creations of an Omnipotent God, Maker and Father of all, we have the enthusiastic, energetic, all-embracing investigations and theories of a Haeckel, a Huxley, or a Spencer, who certainly can not be accused of holding any pronounced religious beliefs whatever. There can be no doubt that this change too was a very natural one; for as long as men felt

that they were studying immutable creatures, there was a sense of restraint in the work, a feeling that investigation had a definite limit beyond which we could not go, and so there was little chance for speculation or theorizing on the nature of causes. When this restraint was suddenly and entirely removed by the theory of evolution the reaction was inevitable, and a strong tendency toward the other extreme set in, clearly shown by the number and variety of the theories that have been suggested and published to explain all kinds of natural phenomena. Scientists have been so entirely taken up with explaining *how* all the wonderful things which we find in the world about us have taken place; the doctrine of evolution has proved so completely satisfactory at every turn that there is great danger that the ultimate motive for scientific research will be completely lost to sight. Indeed, one may search a great majority of scientific works without finding a hint as to any higher motive than mere curiosity,—a curiosity differing greatly in quality and extent in different writers, but very rarely that pure eagerness for "truth" which it sometimes professes to be. So long as the answer to the question How? is the all-important thing, and so long as that is considered the ultimate question, no proper conception of a nobler motive can be formed. But we must now consider if there is not still another question beyond the How? which is as far more important than that as that is beyond the question What? The extraordinary reverence which a certain school of scientists feel toward the question How? is clearly shown by the quotation in the earlier part of this article, and it will, no doubt, be considered impious by them that any one should presume to go beyond that question. At the same time one can not read that criticism without having forced upon him the belief that there is another and greater question to be considered, and that question may be briefly stated in the form of WHY?

It is not by any means a new question, and I claim no merit of originality in bringing it forward here; but since we have come to see the importance of the *means* to the end, we seem to have lost sight of the far greater importance of the *causes* of those means. That is, while we have been busy inquiring *how* things came to be so, we have either confused with that question, or forgotten altogether to ask, the *why*. Probably the first objection that will be raised to the consideration of this question will be the futility of seeking ultimate causes; and the limits of human knowledge will be emphasized to show the folly of going beyond the How? Now, it is no part of my purpose to consider the question whether there is an Absolute Unknowable; but I will merely suggest that when it was first proposed to consider *how* species came to be what they are, it was not only the theologians who raised a great

hue and cry about the impiety and folly of the act; a very large number of scientific men really supposed that the question was beyond the limits of actual knowledge. And yet is not the doctrine of evolution becoming less and less of an hypothesis and more and more of an actually established law every year? Is not the evidence all tending to establish it completely, and to prove that even the obscure problems of life and heredity are all within the limits of human knowledge? Can we then be sure that the knowledge of why evolution has worked as it has is unattainable? Is not the presumption strongly in favor of the probability that some day, somewhere, some race of men, our posterity and the legatees of our knowledge, will know and understand the causes and the "reasons why" which have led to and are now leading toward that

". . . one far-off divine event
To which the whole creation moves"?

If, then, it is granted that this knowledge is a possibility, it is fitting that we should consider whether there is any clew to the solution of the problem in the work already done, and what effect the question will have on the methods and spirit of scientific research. We have already seen how long a time the doctrine of immutability of species held in check the tendency to theorize and led students to devote themselves to the collection and tabulation of facts. Both questions, how and why, were confused together and were answered promptly and positively: "The Creator designed them so"; and there was the end beyond appeal. When it was found, however, that this was really no answer at all to the question How? and that the true answer to that question was within the immediate grasp of the scientific world, the whole argument of design was promptly thrown aside as rubbish, and we were free! But we were not long to remain so, for now we find a new limit set to our knowledge beyond which there is no appeal, and the answer to our question Why? is now given us, "Evolution evolved them so"! Distinguishing now as we do between how and why, we find this limit is equally distasteful and causes a similar feeling of restraint; and it is only natural that, having been freed from the other, we should demand emancipation from this. Why did evolution evolve some birds into objects of such marvelous beauty? Surely we can conceive of peacocks, humming birds, and birds of paradise fully as well, perhaps even better, fitted for the struggle for existence without their gleaming colors and gorgeous plumes. Why are some flowers so fragrant to our sense of smell? We certainly know that it is no advantage to them to please us, as long as they attract insects, and we also know that odor without fragrance will answer that purpose. Was it only chance that brought about these results? It seems incredible

that any person familiar with Nature's conformity to law and the mathematical improbability of inheritance of accidental variation along a favorable line can believe that these marvelous results have been governed only by chance. Surely Nature could never thrive under such a shiftless and haphazard system, and we are therefore justified in searching for the reason why. Not *how* beautiful birds and fragrant flowers were evolved is the essential question, but *why*. Yet we can never hope to know the causes until we know perfectly the means, just as we could never have hoped to know the means until we were tolerably familiar with the ends. Darwin could never have formulated his theory if he had not had the vast array of facts on which to base it, and it would never be proved if men were to give up the gathering of the still unrecorded facts. Of course, all this routine work appears in a new and far more glorious light now, and much the greater number of scientific workers are engaged in the collection of such facts as have hitherto been unknown or overlooked. Only a very few are giving the greater part of their time to theorizing on how evolution works, although we all realize the importance of that question. So it will be when we see that the question Why? is the ultimate one, for there can be no solution of this problem until the lesser ones are solved. It is neither probable nor desirable that any change of method will result, for the present historical system is so far ahead of any other that there is no danger of our giving it up; but it is both probable and desirable that investigators should approach the phenomena of Nature in a different spirit.

As we look about for a clew as to how the question Why? may be answered, let us examine more carefully that dogmatic assertion which we threw aside so promptly when we accepted the doctrine of evolution: "The Creator designed them so." Have we any hint here as to the causes which have governed the evolutionary methods? That depends on some other things which we must examine first. The means by which an end is accomplished we know by experience may be purely impersonal, but *causes* are always dependent on personality. This may not appear at first sight, so prone are we to confuse how and why, but it will be clearly seen by means of an illustration. We are accustomed to say that we know *why* it rains, but in reality we only know *how* it is that it rains—that is, we know the natural processes by which rain is produced. On the other hand, we say we know *why* we went to a given place at a given time, and in this case we not only know how we went, but we do know the actual reasons or causes which put the means at work. If this be granted, as it seems to me it must be, we are at once presented with the condition that the answer to our question *why* is dependent on our

knowledge of the personality who is the cause of the phenomena. If, therefore, the phenomena are in point of time or space as compared with ourselves infinite, their cause must be infinite; and since it is admitted that cause is dependent on personality, we are justified in speaking of an Infinite Personal Being, and our knowledge of the cause of natural phenomena and the origin of natural law will be dependent on our knowledge of that Being whom we may reasonably call God. The dogmatic assertion, then, which we were examining does contain a clew to the solution of the problem. That "the Creator designed them so" is no answer to the question of the origin of species, is palpably evident, nor does it throw any light on the question of *how* things have come to be as they are; but it does *give a clew* as to *why* things are so, although, of course, it *does not answer* the query. If we examine the acts of any person we find that they throw light on his character, and if we become fully acquainted with the means which he has used, we become better acquainted with the character, and as we know that, we come to understand his motives. So we shall find it in the study of natural science. As we learn more and more of the facts of Nature, we shall become better acquainted with the means, and will understand then how things have been evolved; and as we solve these lesser problems we will become better and better fitted to understand why evolution has worked as it has, and to comprehend the character of God. This, then, is the true motive for scientific research, that we may know him who is the only true God, and by knowing his character and motives understand our relations to him. That the appreciation of this motive would have a marked effect on the spirit of scientific work is plainly evident, and, instead of the tone of shallow materialism so common to-day, we would have a religious reverence for truth as it is, without regard to possible effects on our pet theories—that truth which we shall some day know and which shall make us free. The doctrine of design certainly failed to explain the many phenomena of Nature, but that a re-examination of it, or even a temporary acceptance of it as explaining the *why* of those phenomena, means "the death of scientific investigation," is the most arrant nonsense. The universe certainly is the "theater of Will," otherwise there could be no universe; but *it is also* the theater of "forces the operation of which we can hope to understand," and to deny the latter fact is as ridiculous as to ignore the former. Much discredit has been cast on religious teachers and workers because of ignorance and shallow reasoning, but there is great danger that in the closing days of this century scientific teachers and workers will bring discredit on themselves and their calling by an equally erroneous position, not toward religion only but toward Science herself. As soon, however, as one comprehends

the real motive for scientific research all such danger is dissipated, and he will earnestly seek to add his life work as—

". . . a closer link
Betwixt us and the crowning race

"Of those that eye to eye shall look
On knowledge; under whose command
Is Earth and Earth's, and in their hand
Is Nature like an open book;

"No longer half akin to brute,
For all we thought and loved and did,
And hoped, and suffered is but seed
Of what in them is flower and fruit."

PLEASURES OF THE TELESCOPE.

By GARRETT P. SERVISS.

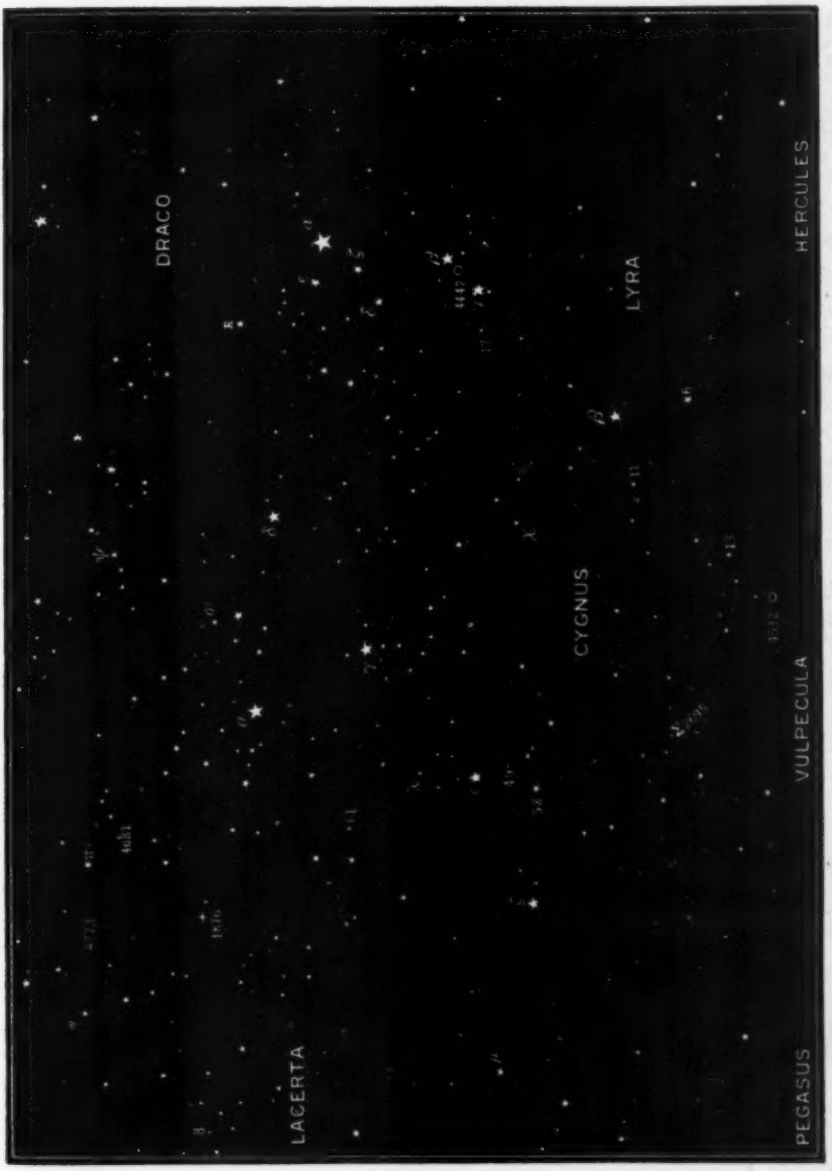
VI.—FROM LYRA TO ERIDANUS.

WE resume our celestial explorations with the little constellation Lyra, whose chief star, Vega (α), has a very good claim to be regarded as the most beautiful in the sky. The position of this remarkable star is indicated in map No. 17. Every eye not insensitive to delicate shades of color perceives at once that Vega is not white, but blue-white. When the telescope is turned upon the star the color brightens splendidly. Indeed, some glasses decidedly exaggerate the blueness of Vega, but the effect is so beautiful that one can easily forgive the optical imperfection which produces it. With our four-inch we look for the well-known companion of Vega, a tenth-magnitude star, also of a blue color deeper than the hue of its great neighbor. The distance is 50″, p. 158°. Under the most favorable circumstances it might be glimpsed with the three-inch, but, upon the whole, I should regard it as too severe a test for so small an aperture.

Vega is one of those stars which evidently are not only enormously larger than the sun (one estimate makes the ratio in this case nine hundred to one), but whose physical condition, as far as the spectroscope reveals it, is very different from that of our ruling orb. Like Sirius, Vega displays the lines of hydrogen most conspicuously, and it is probably a much hotter as well as a much more voluminous body than the sun.

Close by, toward the east, two fourth-magnitude stars form a little triangle with Vega. Both are interesting objects for the telescope, and the northern one, ε, has few rivals in this respect. Let us first look at it with an opera glass. The slight magnifying

power of such an instrument divides the star into two twinkling points. They are about two and a quarter minutes of arc apart, and exceptionally sharp-sighted persons are able to see them di-



Map No. 17.

vided with the naked eye. Now take the three-inch telescope with a moderate power, and look at them. Each of the two stars revealed by the opera glass appears double, and a fifth star of the ninth magnitude is seen on one side of an imaginary line joining

the two pairs. The northernmost pair is named ϵ_1, the magnitudes being fifth and sixth; distance 3″, p. 15°. The other pair is ϵ_2, magnitudes fifth and sixth; distance 2·3″, p. 133°. Each pair is apparently a binary; but the period of revolution is unknown. Some have guessed a thousand years for one pair, and two thousand for the other. Another guess gives ϵ_1 a period of one thousand years, and ϵ_2 a period of eight hundred years. Hall, in his double-star observations, simply says of each, "A slow motion."

Purely by guesswork a period has also been assigned to the two pairs in a supposed revolution around their common center, the time named being about a million years. It is not known, however, that such a motion exists. Manifestly it could not be ascertained within the brief period during which scientific observations of these stars have been made. The importance of the element of time in the study of stellar motions is frequently overlooked, though not, of course, by those who are engaged in such work. The sun, for instance, and many of the stars are known to be moving in what appear to be straight lines in space, but observations extending over thousands of years would probably show that these motions are in curved paths, and some of them, perhaps, in closed orbits.

If now in turn we take our four-inch glass, we shall see something else in this strange family group of ϵ Lyræ. Between ϵ_1 and ϵ_2, and placed one on each side of the joining line, appear two exceedingly faint specks of light, which Sir John Herschel made famous under the name of the *debillissima*. They are of the twelfth or thirteenth magnitude, and possibly variable to a slight degree. If you can not see them at first, turn your eye toward one side of the field of view, and thus, by bringing their images upon a more sensitive part of the retina, you may glimpse them. The sight is not much, yet it will repay you, as every glance into the depths of the universe does.

The other fourth-magnitude star near Vega is ζ, a wide double, magnitudes fourth and sixth; distance 44″, p. 150°. Below we find β, another very interesting star, since it is both a multiple and an eccentric variable. It has four companions, three of which we can easily see with our three-inch; the fourth calls for the five-inch; the magnitudes are respectively four, seven or under, eight, eight and a half, and eleven; distances 45″, p. 150°; 65″, p. 320°; 85″, p. 20°; and 46″, p. 248°. The primary, β, varies from about magnitude three and a half to magnitude four and a half, the period being twelve days, twenty-one hours, forty-six minutes, and fifty-eight seconds. Two unequal maxima and minima occur within this period. In the spectrum of this star some of the hydrogen lines and the D_3 line (the latter representing helium, a constituent of the sun and of some of the stars, which,

until its recent discovery in a rare Norwegian mineral, was not known to exist on the earth) are bright, but they vary in visibility. Moreover, dark lines due to hydrogen also appear in its spectrum simultaneously with the bright lines of that element. Then, too, the bright lines are sometimes seen double. Prof. Pickering's explanation is that β Lyræ probably consists of two stars, which, like the two composing β Aurigæ, are too close to be separated with any telescope now existing, and that the body which gives the bright lines is revolving in a circle in a period of about twelve days and twenty-two hours around the body which gives the dark lines. He has also suggested that the appearances could be accounted for by supposing a body like our sun to be rotating in twelve days and twenty-two hours, and having attached to it an enormous protuberance extending over more than one hundred and eighty degrees of longitude, so that when one end of it was approaching us with the rotation of the star the other end would be receding, and a splitting of the spectral lines at certain periods would be the consequence. "The variation in light," he adds, "may be caused by the visibility of a larger or smaller portion of this protuberance."

Unfortunate star, doomed to carry its parasitical burden of hydrogen and helium, like Sindbad in the clasp of the Old Man of the Sea! Surely, the human imagination is never so wonderful as when it bears an astronomer on its wings. Yet it must be admitted that the facts in this case are well calculated to summon the genius of hypotheses. And the puzzle is hardly simplified by Bélopolsky's observation that the body giving dark hydrogen lines shows those lines also split at certain times. It has been calculated, from a study of the phenomena noted above, that the bright-line star in β Lyræ is situated at a distance of about fifteen million miles from the center of gravity of the curiously complicated system of which it forms a part.

We have not yet exhausted the wonders of Lyra. On a line from β to γ, and about one third of the distance from the former to the latter, is the celebrated Ring Nebula, indicated on the map by the number 4447. We need all the light we can get to see this object well, and so, although the three-inch will show it, we shall use the five-inch. Beginning with a power of one hundred diameters, which exhibits it as a minute elliptical ring, rather misty, very soft and delicate, and yet distinct, we increase the magnification first to two hundred and finally to three hundred, in order to distinguish a little better some of the details of its shape. Upon the whole, however, we find that the lowest power that clearly brings out the ring gives the most satisfactory view. The circumference of the ring is greater than that of the planet Jupiter. Its ellipticity is conspicuous, the length of the longer axis being 78″

and that of the shorter 60″. Closely following the nebula as it moves through the field of view, our five-inch telescope reveals a faint star of the eleventh or twelfth magnitude, which is suspected of variability. The largest instruments, like the Washington and the Lick glasses, have shown perhaps a dozen other stars apparently connected with the nebula. Three of these, seen at Mount Hamilton, are within the inclosure of the ring. A beautiful sparkling effect which the nebula presents was once thought to be an indication that it was really composed of a circle of stars, but the spectroscope shows that its constitution is gaseous.

Not far away we find a difficult double star, 17, whose components are of magnitudes six and ten or eleven, distance 3·7″, p. 325°.

From Lyra we pass to Cygnus, which, lying in one of the richest parts of the Milky Way, is a very interesting constellation for the possessor of a telescope. Its general outlines are plainly marked for the naked eye by the figure of a cross more than twenty degrees in length lying along the axis of the Milky Way. The foot of the cross is indicated by the star β, also known as Albireo, one of the most charming of all the double stars. The three-inch amply suffices to reveal the beauty of this object, whose components present as sharp a contrast of light yellow and deep blue as it would be possible to produce artificially with the purest pigments. The magnitudes are three and seven, distance 34·6″, p. 55°. No motion has been detected indicating that these stars are connected in orbital revolution, yet no one can look at them without feeling that they are intimately related to one another. It is a sight to which one returns again and again, always with undiminished pleasure. The most inexperienced observer admires its beauty, and after an hour spent with doubtful results in trying to interest a tyro in double stars it is always with a sense of assured success that one turns the telescope to β Cygni.

Following up the beam of the imaginary cross along the current of the Milky Way, every square degree of which is here worth long gazing into, we come to a pair of stars which contend for the name-letter χ. On our map the letter is attached to the southernmost of the two, a variable of long period—four hundred and six days—whose changes of brilliance lie between magnitudes four and thirteen, but which exhibits much irregularity in its maxima. The other star, not named but easily recognized in the map, is sometimes called 17. It is an attractive double whose colors faintly reproduce those of β. The magnitudes are five and eight, distance 26″, p. 73°. Where the two arms of the cross meet is γ, whose remarkable *cortége* of small stars running in curved streams should not be missed. Use the lowest magnifying power.

At the extremity of the western arm of the cross is δ, a close

double, difficult for telescopes of moderate aperture on account of the difference in the magnitudes of the components. We may succeed in dividing it with the five-inch. The magnitudes are three and eight, distance 1·5″, p. 310°. It is regarded as a binary of long and as yet unascertained period.

In o^2 we find a star of magnitude four and orange in color, having two blue companions, the first of magnitude seven and a half, distance 107″, p. 174°, and the second of magnitude five and a half, distance 358″, p. 324°. Farther north is ψ, which presents to us the combination of a white five-and-a-half-magnitude star with a lilac star of magnitude seven and a half. The distance is 3″, p. 184°. A very pretty sight.

We now pass to the extremity of the other arm of the cross, near which we find the beautiful little double 49, whose components are of magnitudes six and eight, distance 2·8″, p. 50°. The colors are yellow and blue, conspicuous and finely contrasted. A neighboring double of similar hues is 52, in which the magnitudes are four and nine, distance 6″, p. 60°. Sweeping a little way northward we come upon an interesting binary, λ, which is unfortunately beyond the dividing power of our largest glass. A good seven-inch or seven-and-a-half-inch should split it under favorable circumstances. Its magnitudes are six and seven, distance 0·66″, p. 74°.

The next step carries us to a very famous object, 61 Cygni, long known as the nearest star in the northern hemisphere of the heavens. It is a double which our three-inch will readily divide, the magnitudes being both six, distance 21″, p. 122°. The distance of 61 Cygni, according to Hall's parallax of 0·27″, is about 70,000,000,000,000 miles. There is some question whether or not it is a binary, for, while the twin stars are both moving in the same direction in space with comparative rapidity, yet conclusive evidence of orbital motion is lacking. When one has noticed the contrast in apparent size between this comparatively near-by star, which the naked eye only detects with considerable difficulty, and some of its brilliant neighbors whose distance is so great as to be immeasurable with our present means, no better proof is needed of the fact that the faintness of a star is not necessarily an indication of remoteness.

We may prepare our eyes for a beautiful exhibition of contrasted colors once more in the star μ. This is really a quadruple, although only two of its components are close and conspicuous. The magnitudes are five, six, seven and a half, and twelve; distances 3·2″, p. 121°; 208″, p. 56°; and 35″, p. 264°. The color of the largest star is white and that of its nearest companion blue; the star of magnitude seven and a half is also blue.

The star cluster 4681 is a fine sight with our largest glass. In

the map we find the place marked where the new star of 1876 made its appearance. This was first noticed on November 24, 1876, when it shone with the brilliance of a star of magnitude

Map No. 18.

three and a half. Its spectrum was carefully studied, especially by Vogel, and the very interesting changes that it underwent were noted. Within a year the star had faded to less than the tenth magnitude, and its spectrum had completely changed in

appearance, and had come to bear a close resemblance to that of a planetary nebula. This has been quoted as a possible instance of a celestial collision through whose effects the solid colliding masses were vaporized and expanded into a nebula. At present the star is very faint and can only be seen with the most powerful telescopes.

Underneath Cygnus we notice the small constellation Vulpecula. It contains a few objects worthy of attention, the first being the nebula 4532, the "dumb-bell nebula" of Lord Rosse. With the four-inch, and better with the five-inch, we are able to perceive that it consists of two close-lying tufts of misty light. Many stars surround it, and large telescopes show them scattered between the two main masses of the nebula. The star 11 points out the place where a new star of the third magnitude appeared in 1670. Σ 2695 is a close double, magnitudes six and eight, distance 1·4″, p. 82°.

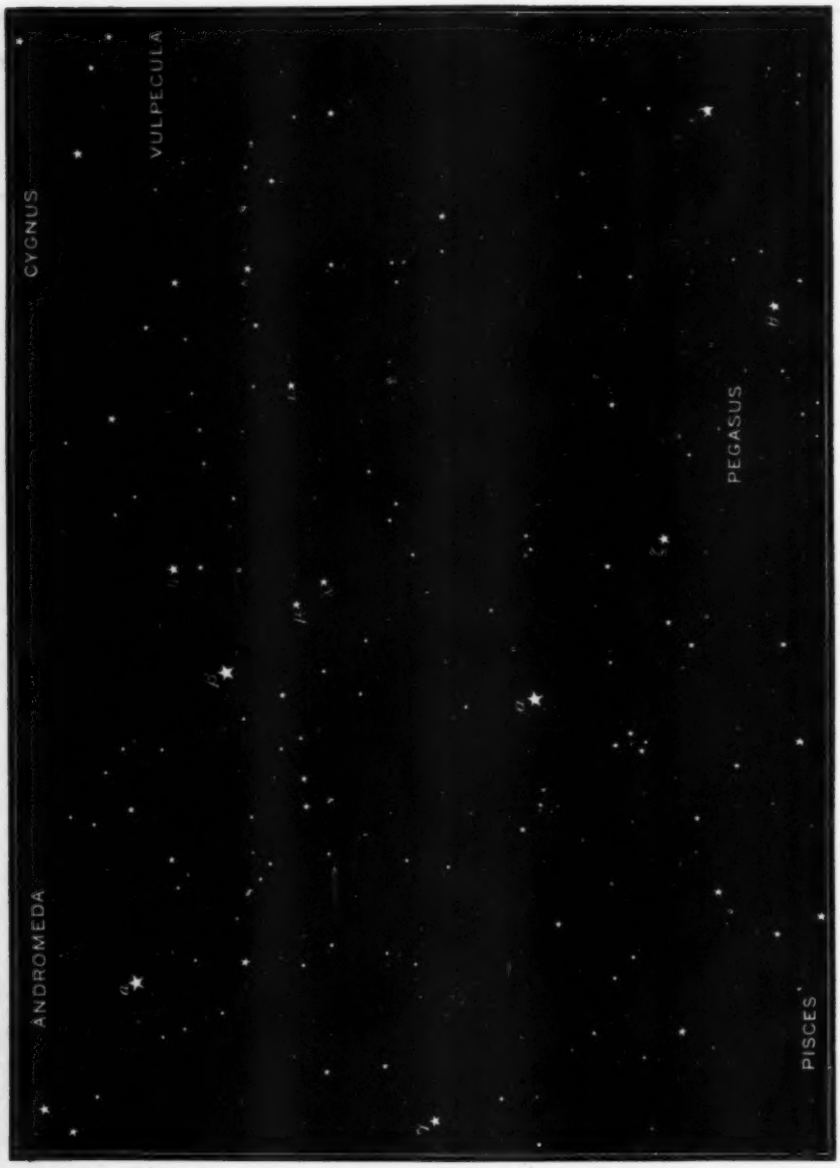
We turn to map No. 18, and, beginning at the western end of the constellation Aquarius, we find the variable T, which ranges between magnitudes seven and thirteen in a period of about two hundred and three days. Its near neighbor Σ 2729 is a very close double, beyond the separating power of our five-inch, the magnitudes being six and seven, distance 0·6″, p. 176°. Σ 2745, also known as 12 Aquarii, is a good double for the three-inch. Its magnitudes are six and eight, distance 2·8″, p. 190°. In ζ we discover a beauty. It is a slow binary of magnitudes four and five, distance 3·3″, p. 325°. According to some observers both stars have a greenish tinge. The star 41 is a wider double, magnitudes six and eight, distance 5″, p. 115°, colors yellow and blue. The uncommon stellar contrast of white with light garnet is exhibited by τ, magnitudes six and nine, distance 27″, p. 115°. Yellow and blue occur again conspicuously in ψ, magnitudes four and a half and eight and a half, distance 50″, p. 310°. Rose and emerald have been recorded as the colors exhibited in Σ 2998, whose magnitudes are five and seven, distance 13·5″, p. 346°.

The variables S and R are both red. The former ranges between magnitudes eight and twelve, period two hundred and eighty days, and the latter between magnitudes six and eleven, period about three hundred and ninety days.

The nebula 4628 is Rosse's "Saturn nebula," so called because with his great telescope it presented the appearance of a nebulous model of the planet Saturn. With our five-inch we see it simply as a planetary nebula. We may also glance at another nebula, 4678, which appears circular and is pinned with a little star at the edge.

The small constellation Equuleus contains a surprisingly large number of interesting objects. Σ 2735 is a rather close double,

magnitudes six and eight, distance 1·8″, p. 287.° Σ 2737 (the first star to the left of Σ 2735, the name having accidentally been omitted from the map) is a beautiful triple, although the two



Map No. 19.

closest stars, of magnitudes six and seven, can not be separated by our instruments. Their distance in 1886 was 0·78″, p. 286°, and they had then been closing rapidly since 1884, when the distance was 1·26″. The third star, of magnitude eight, is distant 11″, p.

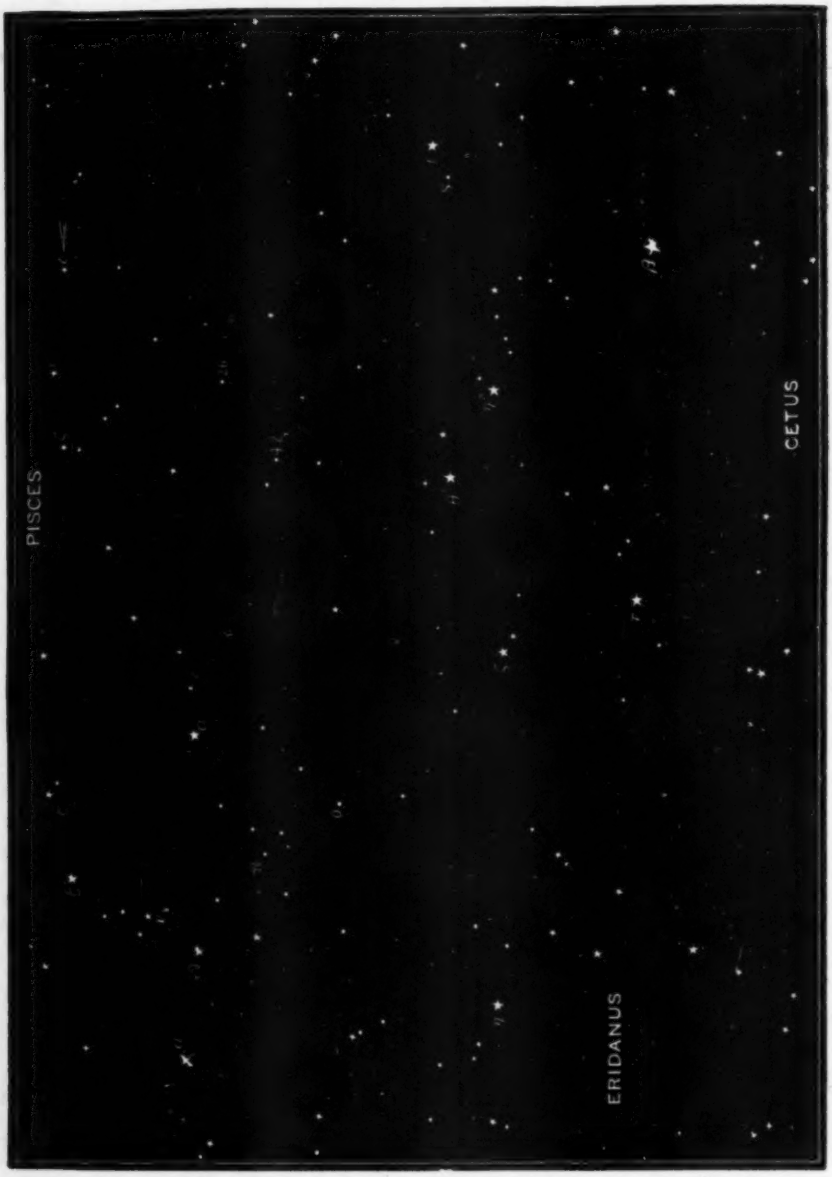
75°. Σ 2744 consists of two stars, magnitudes six and seven, distance 1·6″, p. 171°. It is probably a binary. Σ 2742 is a wider double, magnitudes both six, distance 2·6″, p. 225°. Another triple, one of whose components is beyond our reach, is γ. Here the magnitudes are fifth, twelfth, and sixth, distances 2″, p. 274°, and 366″. It would also be useless for us to try to separate δ, but it is interesting to remember that this is one of the closest of known double stars, the magnitudes being fourth and fifth, distance 0·4″, p. 198°. These data are from Hall's measurements in 1887. The star is, no doubt, a binary. With the five-inch we may detect one and perhaps two of the companion stars in the quadruple β. The magnitudes are fifth, tenth, and two eleventh, distances 67″, p. 309°; 86″, p. 276°; and 6·5″, p. 15°. The close pair is comprised in the tenth-magnitude star.

Map No. 19 introduces us to the constellation Pegasus, which is comparatively barren to the naked eye, and by no means rich in telescopic phenomena. The star ε, of magnitude two and a half, has a blue companion of the eighth magnitude, distance 138″, p. 324°; colors yellow and violet. A curious experiment that may be tried with this star is described by Webb, who ascribes the discovery of the phenomenon to Sir John Herschel. When near the meridian the small star in ε appears, in the telescope, underneath the large one. If now the tube of the telescope be slightly swung from side to side the small star will appear to describe a pendulumlike movement with respect to the large one. The explanation suggested is that the comparative faintness of the small star causes its light to affect the retina of the eye less quickly than does that of its brighter companion, and, in consequence, the reversal of its apparent motion with the swinging of the telescope is not perceived so soon.

The third-magnitude star η has a companion of magnitude ten and a half, distance 90″, p. 340°. The star β, of the second magnitude, and reddish, is variable to the extent of half a magnitude in an irregular period, and γ, of magnitude two and a half, has an eleventh-magnitude companion, distant 162″, p. 285°.

Our interest is revived on turning, with the guidance of map No. 20, from the comparative poverty of Pegasus to the spacious constellation Cetus. The first double star that we meet in this constellation is 26, whose components are of magnitudes six and nine, distance 16·4″, p. 252°; colors, topaz and lilac. Not far away is the closer double 42, composed of a sixth and a seventh magnitude star, distance 1·25″, p. 350°. The four-inch is capable of splitting this star, but we shall do better to use the five-inch. In passing we may glance at the tenth-magnitude companion to η, distant 225″, p. 304°. Another wide pair is found in ζ, magnitudes third and ninth, distance 185″, p. 40°.

The next step brings us to the wonderful variable *o*, or Mira, whose changes have been watched for three centuries, the first observer of the variability of the star having been David Fabri-



MAP No. 20.

cius in 1596. Not only is the range of variability very great, but the period is remarkably irregular. In the time of Hevelius, Mira was once invisible for four years. When brightest, the star is of about the second magnitude, and when faintest, of the ninth

magnitude, but at maximum it seldom exhibits the greatest brilliance that it has on a few occasions shown itself capable of attaining. Ordinarily it begins to fade after reaching the fourth or fifth magnitude. The period averages about three hundred and thirty-one days, but is irregularly variable to the extent of twenty-five days. Its color is red, and its spectrum shows bright lines, which it is believed disappear when the star sinks to a minimum. Among the various theories proposed to account for such changes as these the most probable appears to be that which ascribes them to some cause analogous to that operating in the production of sun spots. The outburst of light, however, as pointed out by Scheiner, should be regarded as corresponding to the maximum and not the minimum stage of sun spot activity. According to this view, the star is to be regarded as possessing an extensive atmosphere of hydrogen, which, during the maximum, is upheaved into enormous prominences, and the brilliance of the light from these prominences suffices to swamp the photospheric light, so that in the spectrum the hydrogen lines appear bright instead of dark.

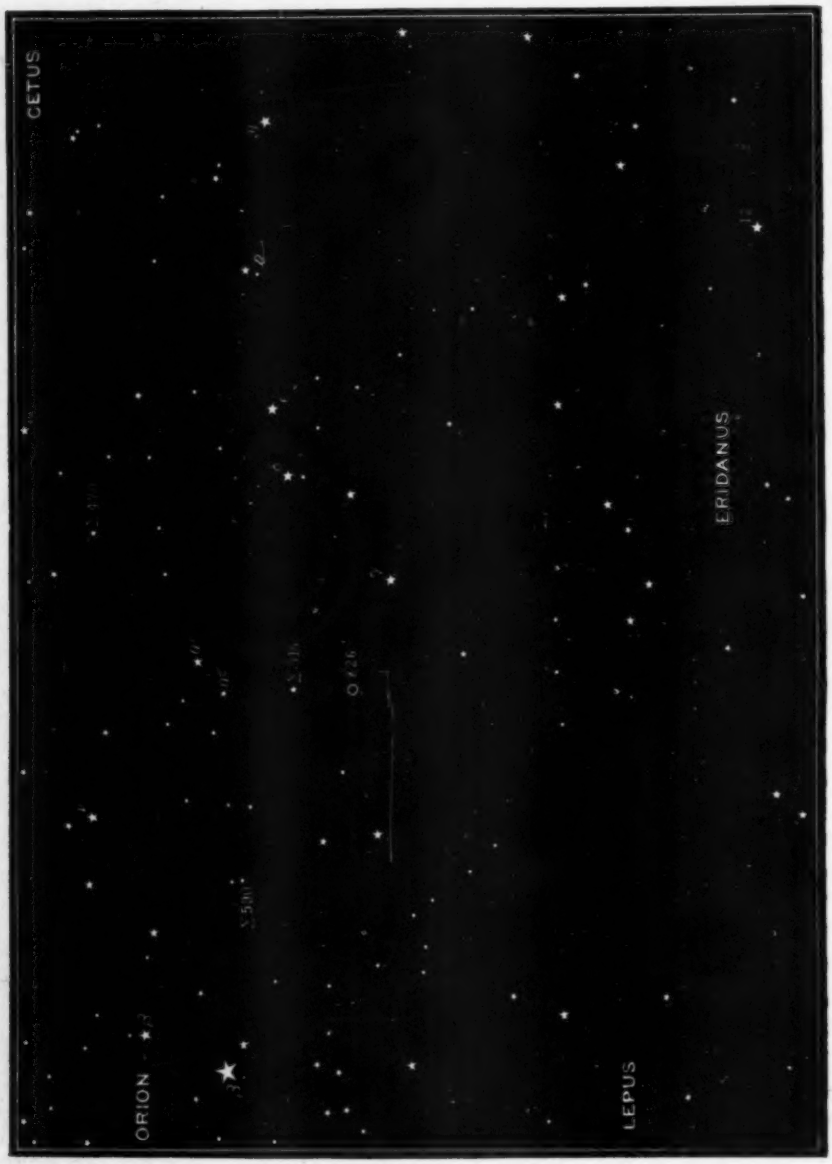
It is not possible to suppose that Mira can be the center of a system of habitable planets, no matter what we may think of the more constant stars in that regard, because its radiation manifestly increases more than six hundred fold, and then falls off again to an equal extent once in every ten or eleven months. I have met people who can not believe that the Almighty would make a sun and then allow its energies "to go to waste," by not supplying it with a family of worlds. But I imagine that if they had to live within the precincts of Mira Ceti they would cry out for exemption from their own law of stellar usefulness.

The most beautiful double star in Cetus is γ, magnitudes third and seventh, distance 3″, p. 288°; hues, straw-color and blue. The leading star α, of magnitude two and a half, has a distant blue companion three magnitudes fainter, and between them are two minute stars, the southernmost of which is a double, magnitudes both eleven, distance 10″, p. 225°.

The variable S ranges between magnitudes seven and twelve in a somewhat irregular period of about eleven months, while R ranges between the seventh and the thirteenth magnitudes in a period of one hundred and sixty-seven days.

The constellation Eridanus, represented in map No. 21, contains a few fine double stars, one of the most interesting of which is 12, a rather close binary. The magnitudes are fourth and eighth, distance 2″, p. 327°. We shall take the five-inch for this, and a steady atmosphere and sharp seeing will be necessary on account of the wide difference in the brightness of the component stars. Amateurs frequently fail to make due allowance for the

effect of such difference. When the limit of separating power for a telescope of a particular aperture is set at 1″ or 2″, as the case may be, it is assumed that the stars composing the doubles on



Map No. 21.

which the test is made shall be of nearly the same magnitude, or at least that they shall not differ by more than one or two magnitudes at the most. The stray light surrounding a comparatively bright star tends to conceal a faint companion, although the tele-

scope may perfectly separate them so far as the stellar disks are concerned. Then, too, I have observed in my own experience that a very faint and close double is more difficult than a brighter pair not more widely separated, usually on account of the defect of light, and this is true even when the components of the faint double are of equal magnitude.

Σ 470, otherwise known as 32 Eridani, is a superb object on account of the colors of its components, the larger star being a rich topaz and the smaller an ultramarine; while the difference in magnitude is not as great as in many of the colored doubles. The magnitudes are fifth and seventh, distance 6·7″, p. 348°. The star γ, of magnitude two and a half, has a tenth-magnitude companion, distant 51″, p. 238°. Σ 516, also called 39 Eridani, consists of two stars of magnitudes sixth and ninth, distance 6·4″, p. 150°; colors, yellow and blue. The supposed binary character of this star has not yet been established.

In o³ we come upon an interesting triple star, two of whose components at any rate we can easily see. The largest component is of the fourth magnitude. At a distance of 82″, p. 105°, we find a tenth-magnitude companion. This companion is itself double, the magnitudes of its components being tenth and eleventh, distance 2·6″, p. 98°. Hall says of these stars that they "form a remarkable system." He has also observed a fourth star of the twelfth magnitude, distant 45″ from the largest star, p. 85°. This is apparently unconnected with the others, although it is only half as distant as the tenth-magnitude component is from the primary. Σ 590 is interesting because of the similarity of its two components in size, both being of about the seventh magnitude, distance 10″, p. 318°.

Finally, we turn to the nebula 826. This is planetary in form and inconspicuous, but Lassell has described it as presenting a most extraordinary appearance with his great reflector—a circular nebula lying upon another fainter and larger nebula of a similar shape, and having a star in its center. Yet it may possibly be an immensely distant star cluster instead of a nebula, since its spectrum does not appear to be gaseous.

Prof. O. C. Marsh regards the discovery of the *Pithecanthropus erectus* in Java as an event equal in interest to that of the Neanderthal skull, and believes that no one can doubt that still other intermediate forms will eventually be brought to light. Nearly twenty years ago he placed on record his belief that such missing links existed, and should be looked for in the caves of the later Tertiary of Africa. The first announcement, however, has come from the East, where large anthropoid apes still survive, and where their ancestors were doubtless entombed under circumstances favorable to early discovery. The tropical regions of both Asia and Africa still offer most inviting fields to ambitious explorers.

ARGON.

THE NEW CONSTITUENT OF THE AIR.

By Dr. JOHN TAPPAN STODDARD,
PROFESSOR OF CHEMISTRY IN SMITH COLLEGE.

ON the 31st of January last the Royal Society of England held a special meeting in Burlington Gardens. Formal invitation to this meeting had been extended to the members of two other scientific bodies, and an audience of at least eight hundred, which included the most distinguished scientific men of England, assembled to listen to the account of the discovery of a new substance in our atmosphere. This discovery, made by Lord Rayleigh and Prof. Ramsay, had been announced at the Oxford meeting of the British Association last August; but five months of patient and strenuous work proved necessary before the investigators felt prepared to publish the detailed results of their research.

Our atmosphere consists essentially of a mixture of oxygen and nitrogen. To the oxygen it owes its power of supporting respiration and combustion; while the nitrogen, inert and incapable of chemical union under ordinary conditions, acts as a diluent, tempering the fierceness of the chemical activity which unmixed oxygen possesses. Both of these gases were discovered more than one hundred and twenty years ago; they have long been recognized as elementary substances, and innumerable analyses have established the proportion in which they occur in air.

When a measured quantity of air, carefully freed from the moisture and carbon dioxide which it always contains, is passed through a tube filled with red-hot copper, the oxygen is fixed by the copper, and the residual gas, amounting to four fifths of the original volume, is found to be incapable of supporting combustion. It is, in fact, what all chemists have considered, up to the time of this brilliant discovery, pure nitrogen.

It is now proved beyond all possible doubt or question that this atmospheric nitrogen is not a single substance, but contains, mixed with it to the amount of about one per cent, another heavier gas, whose existence was previously unknown and unsuspected. To this new substance, which out-nitrogens nitrogen in its chemical inertness, its discoverers give the name of *argon*.*

Besides its occurrence in the free state in air, nitrogen is found in combination in animal and vegetable substances, in saltpeter or niter (from which its name is derived), and is a constituent of

* Argon is derived from alpha privative, and ἔργον, and means not working, idle.

many chemical compounds, from some of which it can readily be prepared. The identification of atmospheric nitrogen with that contained in niter and nitric acid is due to Henry Cavendish, whose exact and skillful work not only established this fact, but led to an observation of great interest in connection with the discovery of argon. In a paper which appeared in 1785 Cavendish says: "As far as experiments hitherto published extend, we scarcely know more of the phlogisticated part of our atmosphere [nitrogen] than that it is not diminished by lime water, caustic alkalies, or nitrous air; that it is unfit to support fire, or maintain life in animals; and that its specific gravity is not much less than that of common air"; and raises the question "whether there are not in reality many different substances compounded by us under the name of phlogisticated air." He then describes an experiment for the purpose of deciding this point. By passage of electric sparks through a mixture of air and oxygen, the nitrogen was converted into a compound absorbed by the dilute alkali over which the gases were confined. The sparking was continued until no further diminution of volume took place, when, on removing the excess of oxygen by absorption in "liver of sulphur," "only a small bubble of air remained unabsorbed." From this he concludes that "if there is any part of the phlogisticated air of our atmosphere which differs from the rest, and can not be reduced to nitrous acid, we may safely conclude that it is not more than a hundred and twentieth part of the whole." Cavendish was apparently satisfied with this as a proof of the simple character of atmospheric nitrogen, and his work has been accepted as conclusive for more than a century; but we now know that this "small bubble of air" which survived his experiment must have been argon.

It seems strange that a substance present in the air all about us, and whose actual quantity is enormous, should have defied detection through so many years of exact and searching chemical work; but the explanation lies largely in the fact that argon forms no compounds, so far as is known, and thus fails to assert itself in the presence of the almost equally indifferent nitrogen with which it is mixed.

Indeed, the hint which led to its discovery was obtained in the course of a purely physical investigation. For some years Lord Rayleigh has been engaged in the exact determination of the densities of some of the more permanent gases. In dealing with nitrogen, it was found that this gas, when prepared from chemical compounds, was about one half per cent lighter than the nitrogen obtained from air. This discrepancy at once suggested contamination with some known impurities. A careful search proved, however, that this was not the case. The possible ex-

planation then occurred, that the lightness of the "chemical" nitrogen was due to a partial dissociation or breaking up of the molecules of the gas into single atoms under the conditions of its preparation. This, too, was negatived by experiment. One or the other of the gases must be a mixture, containing an ingredient much heavier or much lighter than ordinary nitrogen. To suppose a lighter ingredient mixed with the chemical nitrogen required the existence of two kinds of nitric acid, which was out of the question. "The simplest explanation in many respects was to admit the existence of a second ingredient in air from which oxygen, moisture, and carbon dioxide had already been removed."

This explanation was put to the test by an attempt to isolate the suspected gas, with the result that by two entirely distinct methods a new substance was obtained from air.

One of these methods was that of Cavendish, already described. Air confined over dilute alkali is subjected to the action of electric sparks, while oxygen is added from time to time until, with an excess of oxygen present, no further absorption occurs. The oxygen is then removed by alkaline pyrogallate, and argon is left.

The second method for the separation of argon is based on the fact that red-hot magnesium unites with nitrogen, forming a non-volatile compound. Air from which moisture and carbon dioxide have been removed is freed from oxygen by passing it over heated copper, and then from nitrogen by means of magnesium turnings at a red heat. The removal of the last portions of nitrogen is a tedious operation, requiring some two days. The residual gas is pure argon.

The gas obtained by both of these methods is the same, and its behavior proves conclusively that it is a new substance. Prof. Crookes finds that it gives two spectra, according to the strength of the induction current, one characterized by red and the other by blue lines; and testifies that he has "found no other spectrum-giving gas or vapor which yields spectra at all like those of argon"; and that "as far, therefore, as spectrum work can decide, the verdict must, I think, be that Lord Rayleigh and Prof. Ramsay have added one, if not two, members to the family of elementary bodies."

The behavior of argon at low temperatures and under high pressures has been examined by Prof. Olszewski, of Cracow, who is well known for his researches on the liquefaction of air and other gases. Its critical temperature—that is, the temperature at which its liquefaction under pressure first becomes possible—is −121° C., and at that point it is condensed to a liquid by a pressure of 50·6 atmospheres. Liquid argon becomes an icelike solid at a still lower temperature, melts at −189·6°, and boils under ordinary

pressure at −187°. Its critical and boiling points lie between those of oxygen and nitrogen, nitrogen having the lowest of the three.

Argon is four tenths heavier than nitrogen, and much more soluble in water. As already stated, and as is evident from the methods employed for its preparation, argon is more inert than nitrogen; so great is its chemical indifference, that all attempts to bring about reactions with even the most active substances at high temperatures have thus far proved abortive. It is unaffected by phosphorus or sulphur at red heat; sodium and potassium may be distilled in it without loss of their metallic luster; it is unaltered by fused and red-hot caustic soda or niter; aqua regia and other wet oxidizing and chlorinating agents are entirely without action; and it resists the attack of nascent silicon and boron.

Though thus unique in its chemical inactivity, it would be premature to conclude that argon may not form compounds under conditions yet untried,* and that it is an absolutely "idle" and useless thing. Prof. Roberts-Austen suggests that it may possibly play a part in certain metallurgical operations in which air is largely employed. In making Bessemer steel, for instance, not less than one hundred thousand cubic feet of air are blown through each charge of metal for the purpose of removing the carbon, silicon, phosphorus, and other impurities. In this air there must be over one thousand cubic feet of argon. Now, Prof. Roberts-Austen has found by experiment that the nitrogen which can be pumped out of Bessemer-blown metal, and which is twice the volume of the metal, contains little or no argon; and the question arises, whether the argon may not have united with the iron, as nitrogen undoubtedly does, and confer upon Bessemer steel some of the peculiarities which distinguish it from other steel. It is, of course, possible and perhaps more likely that the argon passes through the molten metal without combining with it; but the suggestion is an interesting one, and well worth experimental examination.

Further, it may prove that argon is in some way taken up by plants, and contributes in an important manner to their nourishment and growth; although the attempts to extract argon from vegetable and animal substances have thus far yielded only negative results. As is well known, plants are unable to take nitrogen directly from the air, but obtain it from nitrogenous compounds which are absorbed in solution by their roots. The air is, however, the original source of these compounds, as well as of all

* Berthelot announces that he has succeeded in causing argon to react with certain organic compounds, especially with the vapor of benzene, by means of the silent electric discharge.

other naturally occurring nitrogenous substances, most of which are produced by the life-activity of micro-organisms; and from the natural substances all chemical compounds containing nitrogen are prepared. Considering, therefore, the identity of the source, it seems improbable that the nitrogen of plants or animals should contain argon, while that of inorganic chemical compounds is without it. It is, however, possible that argon may enter the plant in a manner quite different from nitrogen; for it does not follow that, because it is associated with nitrogen in the air, argon must always play the part of an inseparable companion.

Is argon an element, a mixture of elements, or a compound? While the evidence that it is a new substance is indisputable, the facts thus far obtained do not warrant a final decision in regard to its simplicity. There is no reason, however, to believe that it is a compound, but, on the contrary, there is a piece of most conclusive evidence against this view. This evidence is the ratio of its specific heats at constant pressure and at constant volume. This has been carefully determined, and is found to be in exact agreement with the value required by the mechanical theory of heat for a monatomic gas—that is, a gas whose molecules consist of a single atom each. Such a state of things is obviously impossible for a compound, which must have two atoms, at least, in every molecule. It is also unusual in elementary gases, whose molecules are in most cases diatomic, or of two atoms each. Argon is therefore either an element or a mixture of elements having structureless molecules. This evidence throws out of court also the view, which has been repeatedly urged since the first announcement of the discovery, that argon is an allotropic form of nitrogen, consisting of triatomic nitrogen, and analogous to ozone, which is triatomic oxygen.

As to the question whether it is a single element or a mixture, the argument for the mixture is based on the fact that it gives two spectra. Though suggestive, this can not be looked on as conclusive, for certain well-known elements—hydrogen and nitrogen—show the same peculiarity. On the other hand, a definite melting point, a definite boiling point, a definite critical temperature and pressure, all of which argon possesses, are generally accepted criteria of a pure substance. The evidence, therefore, is largely in favor of the simple elementary character of argon.

If subsequent investigation confirms this view, and argon proves to be a single monatomic element, a question of great interest is raised. For many years an accepted law of chemistry has been expressed in the so-called periodic classification of the elements. When the elements are arranged in the order of their atomic weights, the series may be broken into a number of well-defined periods, whose members show marked analogies to the

corresponding members of the other periods, and a regular gradation of properties among themselves; or, in other words, "the properties of the elements and of their compounds are a periodic function of their atomic weights." The exigencies of classification, so that the elements of different periods may fall into their proper places in the tabulated scheme, have left many gaps in the table, which may represent elements yet awaiting discovery. In fact, three such elements have been discovered since the first formulation of the periodic law by Mendeleeff, and found to agree very exactly with the prediction made several years previously by Mendeleeff for the properties of elements which might be expected to fill certain gaps.

Now argon, if it is a monatomic element, must have an atomic weight of about forty. There is, however, not only no vacant place in the table for an element of this atomic weight, but the properties of the elements occupying this region are wholly unlike those of argon. Thus for the first time in its history the periodic law would fail in its hitherto triumphant provision for the results of discovery.

A law which expresses so much undoubted truth, and which has proved of such great service in the past, is not, however, to be at once discredited because it seems not to provide for this case. So great is the confidence felt in it, that many chemists consider its apparent failure in this case a conclusive argument against the monatomic character of argon. It must be remembered, however, that the evidence for monatomicity is founded on a deduction from the thoroughly established mechanical theory of heat; while the periodic law is, after all, as Prof. Rücker says, "an empirical law, which rests on no dynamical foundation," for which no adequate theory has yet been found. More evidence is needed in the case, and more will probably soon be forthcoming. Meantime the present situation will strengthen the feeling, by no means new, that, while the periodic law is a grand generalization containing much that is true, it is certainly not a complete or final expression of the relations which exist between the properties of the elements and their atomic weights, but rather a first approximation to the law which may ultimately be formulated.

Whatever the outcome of these speculative issues, there can be but one opinion in regard to the discovery itself. From every point of view it is a masterly achievement. The elements of recent discovery have all been metals which occur in minute quantities in rare minerals. No nonmetallic element has been discovered for nearly seventy years, and the existence of another element belonging to this group did not seem probable; still less likely did it appear that such an element could be present in our atmosphere.

The discovery has well been called "the triumph of the last place of decimals"—that is, of work so exact that the worker knew that the small differences in the figures he obtained must be due to the presence of an unknown substance rather than to an error in his results. The prediction based on this observation, the search for the disturbing substance, and its discovery, form an achievement which, in the history of science, has perhaps only been surpassed by the prediction of Neptune by Adams and Leverrier, and its subsequent discovery by Galle.

THE NERVOUS SYSTEM, AND ITS RELATION TO EDUCATION.

By JOHN FERGUSON, M. A., M. D., Ph. D.,
TORONTO.

JOHN LOCKE, the physician and philosopher, long ago said that all our knowledge came from experience. Throughout his Treatise on the Human Understanding he develops this view of the acquisition of knowledge. This was followed by the writings of David Hume, the Scottish historian and metaphysician, who held that we knew nothing of objects in themselves, but only through their qualities; or, in other words, that we know of nothing but ideas. This was in turn followed by Immanuel Kant's Critique of Pure Reason, who took the ground that, though all our knowledge did not come from experience (as taught by Locke), yet it all came by experience. He held firmly to the ground that we had intuitions, or an *a priori* knowledge. It was this intuitive power that enabled us, by experience, *a posteriori*, to acquire knowledge of the qualities and of the forms of matter. Later came those who, like Ribot, Spencer, Romanes, have taught that there is no science of mind apart from the operations of the nervous system; that the operations of the brain constitute what is known as mental processes. Differing from these, the late T. H. Green held, as did Kant, that there is a science of ethics and psychology, independently of the study of physiology.

Fortunately for the purposes of this article, it will not be necessary to review the opinions of the above writers; it will not be necessary to prove which of the many views is correct. This much is definitely known: that certain physiological laws govern the human body, so as to determine what we know and how we came to know it. The intuitions of Kant, the common sense of Locke and Reid, the skepticism of Hume on knowledge, the idealism of Berkeley, need not detain us, as they have no special interest for the present. The object before us is to show that we

come by our knowledge through experience, and in what manner experience acts upon our nervous system.

It is, therefore, the nervous system which we have to do with in every system of education. It will go with the saying that the better the condition of health in the nervous system, the better will it be for the plans of education. One of the fundamental laws that must govern all methods of education is the care of the health of those who are being taught. A normal condition of the conducting nerves and perceptive centers is necessary to a normal type of the perceptions gained by experience. In all schools and colleges sanitary principles ought to have the most thorough consideration. Impure air, either from bad ventilation or drainage, may do more harm to a number of children than the most eminent teacher can do good. If the brain is not well supplied with an abundance of nourishing and pure blood, its functions can not be well performed. It is a poor waste of time to teach a child, unless what is taught is imparted under such circumstances as to be remembered; and how can impressions made upon the brain become fixed and retained unless it is in a fit condition of health, activity, nutrition, and rest? *Mens sana in corpore sano* is now and always will be true.

Granting that the school or college is in a sanitary condition, and that there is a proper mixture of recreation in the hours of study, the individual characteristics of each pupil deserve to be taken into account. No teacher does his duty who does not make each pupil placed under his charge a careful character study. It is true this takes much time and requires much judgment; but it is far more than repaid by the greater progress that can afterward be made by the teacher with such a pupil. Some children who may be naturally truthful are, nevertheless, extremely sensitive to pain, and as a consequence will lie to escape punishment. Others, again, are instinctively prevaricators; while some are so constituted as to have no fear of corporal punishment. The hope of reward will stimulate one child to diligence; but no such result is produced in a second. One will study from a love of the work; whereas another looks upon all study as a useless waste of time, and a weary drudgery. Individualism should therefore play an important rôle in the management of every school. The teacher must ever fall far short of true success who does not or who can not become familiar with the many differences thus to be found in the mental and ethical qualities of his class.

Prenatal and postnatal influences may have seriously impaired the child's health, and especially that of its nervous system. Nature has done much to protect her works from the destructive and injurious effects of their environments. But, in spite of this, the conditions of life and development may have

been so bad that the child is started on its journey with an organism full of twists and irregularities. Mirabeau was once asked when he would commence the education of a child. "Twenty years before it is born" was the philosophic answer. The prenatal influences of heredity can not be overestimated. An unhealthy, depraved, immoral, and vicious parentage tells its sad tale through the offspring. Tennyson is as correct to science as he was poetical when he said:

> "'Tis the blot upon the brain
> That will show itself without."

It matters nothing whether the views of Darwin shall stand the test of future investigation, that acquired characteristics can be inherited; or the views of Weissman, that they can not. The fact remains that a weak and diseased nervous organism is much more liable to take on a perverted growth and development than one that is ushered into the world free from such blemishes. One of the prime objects in every system of education ought therefore to be the studious care given to the health of the scholars, so as to avoid damaging those who are as yet sound, and in order to remove as far as possible the blots that have already been made upon the nervous mechanism of others, and that must show themselves without.

"*Nihil est in intellectu quod non prius fuerit in sensu* (There is nothing in the intellect that has not first come through the senses)." Philosophy and experience alike confirm the truth of the above. When the child is born, its mind is like a sheet of white paper, as Locke expresses it; but soon there begin to be impressions made upon it, as characters may be inscribed upon the paper. It is now some two hundred and seventy-five years since Comenius recognized that children gain their knowledge through the senses, and that these should be properly educated on suitable objects. He strongly urged that matter, and not form, should be presented to children. We should "cease to persuade, and begin to demonstrate; cease to dispute, and begin to look." An old Latin writer puts it thus: "*Iter longum est per precepta; breve et efficax per exempla* (The way is long by precept; short and effective by example)."

With Kant and Green I agree that there are certain *a priori* intuitions, such as those of time and space. But I also agree with Kant, Locke, Reid, Spencer, and others, that our knowledge comes through experience. It is of the utmost importance that the experiences to which a child is subjected should be of a proper kind; that they should be of such a kind as to develop the mind in wise directions, and store it with ideas of a useful and ennobling nature. The teachers under whom a child is placed, the

company it is allowed to keep, the books it is permitted to read, should be the subject of the greatest care. John Stuart Blackie once said that the most inspiring thing for a young man was to be placed in the company of great and good men; and next to being in their company was to read their books and to read about them.

But while it is of the greatest importance that the experiences to which the child is exposed are of the best possible character, it is no less important that the nervous system and the sense organs of the child be in a sound and normal condition. The state, through the public-school system, is supplying buildings and teachers at great expense. All this outlay is for the purpose of imparting learning to the rising generation. Is it not right and proper that the state should see that the children upon whom this enormous sum of money is being spent are in a fit condition to receive the education that is offered? One would hardly think of any government spending millions upon an army, and making no selection of the men who were to form this army. Further, when the authorities had selected the men for the army, they would surely see that the benefits of training and drill would not be destroyed by dissipation and irregular habits among the soldiery.

Thus I think it is clearly the duty of the state to exercise its authority in the suppression of injurious books, papers, and advertisements. It is high time that stringent steps were taken in this direction. It does seem strange that large sums are paid annually to furnish children with good reason and morals, and at the same time numerous presses are turning out tons of reading matter of the most degrading and perverting nature. There is still another reform that could be well introduced. A proper medical inspector should be appointed to examine schools and determine their sanitary condition. All matters of drainage, heating, lighting, and ventilation would be subjects for his consideration. It is hardly to be expected that the nervous system and special senses of the pupils will be healthy if these children are pent up for a good portion of the day in an unhealthy schoolroom. Further, it ought to be the duty of this medical inspector to give the pupils of each school under his control regular instruction on hygiene, and especially on the hygiene of study and the care of the sense organs. A teacher may be a very intelligent person, yet the ordinary reading he may have bestowed upon these topics would not enable him to do them the same justice that a well-educated and experienced medical practitioner could. Cases of melancholia, hysteria, chorea, epilepsy, defects of vision, and such like, would be sent home by him for proper rest and treatment.

Children learn best what they like best. Pleasure in their

studies is an all-important factor. I remember once reading in an old book a conversation that took place between Sir Walter Scott and the driver of a stagecoach. Scott was sitting on the seat along with the driver. The conversation turned upon a group of children coming out of an old-fashioned schoolhouse. The driver remarked that the teacher had great influence with his classes, and that his pupils made much progress in learning. Whereupon Scott inquired after the reason for such a happy state of affairs. He was informed by the stage man that the teacher worked on the lines of the old proverb that, "to be successful with children, you must allure the ear, inform the mind, and then impress the heart." This teacher was wise in his day. He sought to win the affections of the child. He established a confidence between himself and his pupil—in other words, he tried to make things agreeable. This accomplished, he commenced to fill the pupils' minds with new thoughts and new relations. The world of ideas was opened up to the child, which was made to see, feel, hear, and remember as it had never done before. On this an ethic or moral system was planted. The late George Paxton Young, Professor of Moral Philosophy in the University of Toronto, often repeated in my hearing that, when he was a boy, he would have been punished for using a translation in the study of a Greek or Latin author. Now, however, if he had had his way, he would punish a student who would not make use of such an aid to promote his advancement and increase his pleasure in the study of the classics. "Pleasure and pain," said Locke, "are the hinges on which all our passions turn." The school life of the child ought to be so managed that its search after knowledge would be one continuous pursuit of pleasure.

Then, again, while it is necessary to present objects to the various senses in order that an acquaintanceship with them may be formed, it is equally necessary that these objects be properly selected and graded according to the age and understanding of the learner. When a pupil is not learning, it is not the fault of the child so much as it is of the teacher. Things have not been presented to the child in proper order or of suitable kind. It is quite true the child may be dull. Its mental development may be a long way behind that of another child of the same age; but this is not the fault of the child. It is the duty of the teacher to take things as he finds them, and to grade his teaching to meet the capacities of the pupil. The age of the pupil does not enable one to decide what may be the degree of perceptive power. This must be tested. It is an utter waste of time to present to a child too complex thoughts or ideas; it must be conducted from the simple to the complex. A child is often found fault with for not giving attention to study. The truth is that things have not

been presented to it in such a manner as to interest it. In all cases where the matter is brought under the child's notice in such a way that it clearly understands it, there will not likely be much ground for complaint on the score of lack of interest. But a still further reason for lack of interest in study is that too often the teaching seems to the child to have no connection whatever with its outside life. Children soon learn to make inductions from their experience. If they can see no connection between what they are being taught and their experiences in life, there will certainly be a want of interest in their studies. It is a matter for congratulation that so much has been done in this direction. The natural method of teaching has made great progress, but much remains yet to be done. The most primitive schoolhouse in the land affords abundant facilities for the education of the child's senses, and, through them, its powers of observation. It is all contained in the simple question, Does the teacher understand the rational method of appealing to the child's intellect through its senses?

The teacher ought to be a close student of Nature. There is placed under his control a large number of young persons of the most varied possibilities. In the schoolroom we have a collection of members of the highest order of animal life. Every member of the class should be made to realize that there is the possibility of a great future in store for him. The imagination and ambition should be enlarged in wise directions. It is quite true these ambitions may never be realized; but the mental stimulus they give the growing youth is of a most valuable character. A high code of ethics should be found in every school; but this must have its fountain head with the teacher. I am not confounding ethics with religion. There was a high ideal of ethics in Plato and Aristides, though pagans; there was a high code of ethics revealed in the life of Darwin, though an agnostic; and there was a high code of ethics running through the life and writings of F. D. Maurice, who was a beautiful type of Christian character. Schiller, the German poet, has truly said: "It is an admirable proof of infinite wisdom that what is noble and benevolent beautifies the human countenance; what is base and hateful imprints upon it a revolting expression." Through the child's senses, feelings, and affections you must reach its soul, whatever this may be regarded to mean by different schools of thought, avoid inflicting scars upon it, and endeavor to erase those that may unfortunately have been made by former bad environments. Such a work as Mantegazza's Expression and Physiognomy should be in the hands of every teacher.

But the teacher must carry his studies in this direction further than that of mere expression and physiognomy. He ought

to be a careful student of physiology and the laws of health. A thorough knowledge of the scientific principles of healthy exercise and study enhances a teacher's usefulness. If the adage "knowledge is power" be true anywhere, surely it is true here. Possessed of a knowledge of the anatomy and physiology of the nervous system—a task which any intelligent teacher could master in a few months—he can deal with the whole question of the education of his class under a new and clearer light. Much that was a mystery to him regarding the acquisition of knowledge will become plain. The complex memory of a flower will be resolved into the memories of its several qualities, that were carried to the brain by conducting nerves. The association of ideas and the laws governing the same will be as simple as a lesson in elementary botany. The smelling of a rose reviving the memory of its color will cease to be an enigma. It will then become clear how a person may lose the power of speech and still be able to write and read; or how he may be able to read and write, although unable to hear spoken words; or, again, how he may have lost the power of hearing spoken words, and yet be able to speak, read, and write.

If any one should say that such a knowledge of the physiology of the nervous system in its relation to the acquisition of learning is of no use to the teacher, then I would reply that it is not necessary for the engineer to understand the engine he is running, the mariner the course he is sailing over, nor the farmer the nature of the soil he is tilling. The teacher has a number of young human beings placed under his charge. He is guiding them into the wide ocean of truth and thought. He is laying the foundations on which the future structure of their intellectual and moral natures are largely to be built. He is working with one of the grandest mechanisms known to man—the brain of the child! He ought therefore to know not only what he has to teach, but the subject that has to be taught and the best methods of teaching it. It can not be too strongly urged that if there be any derangement or want of harmony in these factors much of the good that might follow is lost. In order that the relationships between the nervous system and education be properly maintained the teacher must be thoroughly familiar with all three great divisions of his work—the things to be taught, the methods of teaching them, and the brain and sense organs that are to be developed. When the teacher has made himself master of the channels through which the child must acquire its knowledge it becomes an easier and a far more interesting work for him to select topics within the range of the child's understanding and experience. If he is a wise teacher he can build up the child's powers of observation for natural phe-

nomena by leading from simple experiences to those that are more complex. But the great beauty of such teaching is that the child itself feels an interest in its work. It is learning as a pleasure and not as a drudgery.

People in general know what is meant by a natural or rational method of doing a certain task or carrying on to completion a given work. It is astonishing that the very opposite of a natural system should have prevailed so long in the important matter of the education of children throughout the schools of all countries. There have not been wanting some who, at different periods, have called attention to the wrong methods in vogue; but until recent years no very decided advance has been made. Too much importance can not be attached to the fact that in all well-regulated schools such subjects as botany, chemistry, and zoölogy should be taught by means of the objects under study. How much more natural it is to take a rose flower and carefully explain all its parts by pulling it to pieces than to attempt to give a class of young children a knowledge of the same flower by talking about it, without the object being in the hands of the teacher and class! By means of the objects the analogies and differences between the root, stem, and branch, or between the leaf, flower, and seed, can be shown and demonstrated to the class. Lessons conducted properly in this manner become a delight to children, and they come to regard their teacher as a true friend.

Let us examine how we come by a general idea, concept, or notion. Here we must call in the aid of language in naming abstractions. Under this there are ideas of complex character that exist in the mind without the need of language. Still more fundamental than these are simple conceptions carried to the perceptive centers by the ingoing nerve currents. Take the example of an ordinary cube. The child looks at it, and there is a visual impression formed of its color, of the length of each side, of the area of a surface, of the combination of the surfaces so as to give rise to the idea of solidity. The simple ideas are combined into the more complex idea—the visual one of a cube. But by the aid of touch other qualities can be ascertained. The hardness, weight, sharpness of edges and angles, smoothness or roughness of surfaces, form the tactual idea of a cube. But the visual and tactual ideas are still further combined into a general idea or concept to which the name cube is given. In this general idea or concept other qualities may enter, as, for example, the taste of the cube, if it is a sapient object. When the word cube is spoken, it recalls some, or all, of these qualities, according to the knowledge and observation of the person to whom the word is addressed. In the case of a child, the word cube may convey no definite recollection of the object mentioned. The child may not

have been taught to observe the surfaces, edges, angles, etc., of a cube. The word will, therefore, recall only so many memory pictures of the cube as the child has acquired. But point out some new quality in the cube, and a new memory picture of the cube is formed in the child's mind. When in future the word cube is spoken the child will have a more complete memory of it—in other words, a more complete knowledge of it. The process can be continued until all the qualities of the cube are known to the child, and form parts of its concept or notion of the cube. This notion, or memory, is represented in language by the word cube. The simple ideas or conceptions of its color, shape, weight, hardness, go to form the general idea.

Now, grant that the teacher understands how the visual impressions are carried by the eye to a certain center in the brain; how the tactual are carried by conducting nerves to another center; and how the impression of the spoken word is carried by the ear to still another center. Further, he is supposed to know how these centers are connected with each other, so that hearing the word cube spoken recalls the memories of its shape, surfaces, angles and edges.

Armed with such a knowledge of the mechanism of the nervous system as the basis of thought, the teacher has a magic wand in his possession by means of which he can stimulate his pupils, and make what would otherwise be dreary enough work more interesting than a high-class novel or the story of an exciting adventure. There will then exist in the teacher's mind a reason for the natural method of teaching by appealing to the child's experience of things, and for showing it the object about which a certain lesson is to take place. The *Ding an sich* of Kant becomes known inductively, as Spencer and Romanes have shown, through an experience with its qualities. This sort of knowledge does not lead to either the idealism of Berkeley nor the skepticism of Hume, but to a true, scientific psychology as expounded by Wundt and Ribot.

In the past, and indeed at present, far too much time has been spent in instructing the child by telling it certain facts, and not enough time in teaching the child how to observe for itself. We can not see through other people's eyes, nor is their reasoning our reasoning. The power to repeat certain formulæ or to give answers to certain questions does not indicate knowledge on the part of the child. The great object of education is to make the individual capable of solving his own problems, of doing his own reasoning, of looking after his own affairs, of performing his duties as a citizen, of improving himself socially and morally, and of earning an honest living.

Thus it becomes clear that our knowledge is an aggregation of

sensuous impressions. These senses must be made the special object of study and care on the part of the teacher. His great duty is, not so much to tell his pupils what to do or how things happen, as to instruct them how to find out for themselves. There are a number of avenues through which he can reach the child's internal mind. These avenues must be made use of, and the child must be taught how to use them for its own advancement. The ears can be educated, but only practically, to recognize what is meant by pitch, volume, quality, loudness, intensity, harmony, etc., in musical notes. Only by practice can the child be brought to recognize the many shades of color, the divergence of angles, the approximate lengths of objects, or the rapidity of motion in a passing object. The method of Zadig could be made use of in endless variety. A horse's footprints are seen in the sand. The child could be tested on its powers of observation as to whether the horse had been walking, trotting, or galloping; whether he was a large animal or not; whether shod or not, and if the shoes were new; or whether the horse was lame, as might be indicated by one of the footprints. In like manner the tactile and muscular senses may be developed and rendered extremely acute in their power of fine distinctions as to quality, weight, firmness, shape, composition, and such like of the objects that are made the subjects of study. See, for example, what a blind person can do, guided by the sense of touch and the muscular sense.

What has been said by no means exhausts the important relationships of the nervous system to the many problems of education. It is now time that a knowledge of physiological psychology should form a part of the qualifications of every person who becomes a public teacher. It is to be feared that there are many teachers at the present moment who know literally nothing of the wonderful organisms under their charge. We do not so act in business affairs. We do not permit a man to take charge of a locomotive until he has acquired a knowledge of the engine. But we allow men to become the educational engineers of our children without exacting from them the slightest knowledge of the beings they are going to take charge of. I need not state the case more strongly than that this should cease.

One word more. The time has come when strong opinions ought to be expressed against the too prevalent custom of crowding the child with studies and cramming its mind with disconnected facts. Away with the idea that such is education! It is not. Such a system is only a means of injuring the child's health and interfering with its proper mental development. The child's brain and nervous system must be developed along judicious lines, and through this development the mind is enlarged. Nothing is education that does not foster and bring about this

result. I can not do better than end this article by quoting the resolution passed at the recent meeting of the Canada Medical Association: "That the system of education in force in the Dominion draws too largely upon the brain tissue of children and materially injures their mental and bodily health."

TO BÁRBARA.

(*A Study in Heredity.*)

By DAVID STARR JORDAN.

LITTLE lady, cease your play
For a moment, if you may;
Come to me, and tell me true
Whence those black eyes came to you.

Father's eyes are granite gray,
And your mother's, Bárbara,
Black as the obsidian stone,
With a luster all their own.
How should one so small as you
Learn to choose between the two?

If through father's eyes you look,
Nature seems an open book—
All her secrets written clear
On her pages round you, dear.
Better yet than this may be
If through mother's eyes you see;
Theirs to read—a finer art—
Deep down in the human heart.
How should one so small as you
Choose so well between the two?

Hide your face behind your fan,
Little black-eyed Puritan;
Peer across its edge at me
In demurest coquetry,
Like some Doña Plácida,
Not the Puritan you are.

Subtle sorcery there lies
In the glances of your eyes,
Calling forth, from out the vast
Vaults of the forgotten past,
Pictures dim and far away
From the full life of to-day,
Like the figures that we see
Wrought in ancient tapestry.

This the vision comes to me:
Sheer rock rising from the sea,
Wind-riven, harsh, and vertical,
To a gray old castle wall;
Waving palms upon its height,
At its feet the breakers white,
Chasing o'er an emerald bay,
Like a flock of swans that play;
Tile-roofed houses of the town,
From the hills, slow-creeping down;
Rocks and palms and castle wall,
Emerald seas that rise and fall,
Golden haze and glittering blue—
What is all of this to you?

Only this, perchance it be,
Each has left its trace in thee;
Only this, that Love is strong,
And the arm of Fate is long.

Deeply hidden in your eyes,
Undeciphered histories,
Graven in the ages vast,
Lie there to be read at last:
Graven deep, they must be true;
Shall I read them unto you?

Once a man, now faint and dim
With the centuries over him,
Wandered from an ancient town,
On its hills slow-creeping down,
O'er the ocean, bold and free,
Roved in careless errantry.
With Vizcaino had he fared,
And his strange adventures dared;
Restless ever, drifting on,
Far as foot of man had gone;

On his cheek the salt that clings
To the Headland of the Kings,
Flung from the enchanted sea
Of Saint Francis Assisi!
Rover o'er the ocean blue—
What has he to do with you?

Only this: he sailed one day
To your Massachusetts Bay,
And this voyage was his last,
For Love seized and held him fast.
Of that old romance of his
None can tell you more than this;
Saving that, as legacies
To his child, he left his eyes,
Black as the obsidian stone,
With a luster all their own,
Seeing as by magic ken
Deep into the hearts of men.
And mid tides of changing years,
Dreams and hopes and cares and fears,
Life that flows and ebbs alway,
Love has kept them loyally.

Once, it chanced, they came to shine,
Straight into this heart of mine.

Little lady, cease your play
For a moment, if you may;
All I ask is, silently,
Turn your mother's eyes on me!

CONSULADO INGLÉS, CALLE DE LAS OLAS ALTAS, MAZATLAN, SINALOA,
January 10, 1895.

ACCORDING to Captain Younghusband, lately assistant English resident at Chitral, a mountain district of India which has just been attracting considerable attention, the principal evil in the mountains outside of his station is the want of desire for money. The mountaineers, secluded from mankind amid their hills, have never used any money, and consequently have no idea of the value of coins. They took the rupees to be ornaments, and were greatly aggrieved when after carrying loads up the hills they were paid only in little bits of silver. But the government wanted work done, and, not being willing to force labor, had to train the people to the use of money, so they brought peddlers up from the plains. Then, when the people found they could get the goods they wanted with their rupees, they were willing to take them.

THE WORK OF IDEAS IN HUMAN EVOLUTION.

By GUSTAVE LE BON.

THE study of the different civilizations that have succeeded one another since the origin of the world proves that they have always been guided in their development by a very small number of fundamental ideas. If the history of peoples should be reduced to the story of their ideas, it would not be very long. We have shown in a previous essay that the evolution of a people is chiefly derived from its mental constitution. We found then that while the hereditary sentiments, the aggregation of which constitutes character, have great fixedness, they can nevertheless be transformed slowly under the influence of various factors. Among the most operative of these factors are ideas. But, for ideas to have influence, they must have progressively come down from the mobile regions of the conscious into the stable and unconscious regions of the feelings, where our thoughts and the motives of our actions are elaborated. They then form as it were a part of the character and act effectively on the conduct. When ideas have undergone this modification, and are fixed in the unconscious, their power over the mind is absolute. They cease then to be influenced by the reason. The convert who is dominated by a religious idea or by any belief is inaccessible to all arguments, however intelligent we may suppose him to be.

Governing ideas, formed as we have described, become established and disestablished very slowly. If it were otherwise, civilizations would have no stability. But if ideas, once established, could not be gradually transformed, and finally disappear, peoples would achieve no progress. In consequence of the slowness of our mental transformations, many human ages are required for the triumph of a new idea, and several ages more for its elimination. The most civilized peoples are those whose directing ideas have been maintained at an even distance from variability and fixity. History is strewn with the wrecks of those who have not been able to maintain this equilibrium.

The reader of history is struck with the paucity of the ideas of peoples, the slowness with which they are modified, and the power they exercise. Civilizations are the resultants of certain ideas, and when these ideas are changed, the civilization is inevitably transformed with them. The middle ages lived on two fundamental ideas—the religious and the feudal. From them issued all the arts of the period, its literature, and its whole conception of life. At the Renascence these ideas underwent a slight modification: an ideal recovered from the ancient Greek and Latin world imposed itself on Europe, and transformation of the

conception of life, of the arts, philosophy, and literature at once set in. The authority of tradition was shaken, scientific truths began gradually to take the place of revealed truths, and civilization entered upon a new phase. To-day the old religious ideas have lost the greater part of their empire, and for that reason alone all the social institutions that rested upon them are threatened with dissolution.

Regarding ideas according to the importance of their working rather than to their worth, we may divide them into two classes. First are the great general directing and permanent ideas on which an entire civilization rests—the feudal and religious ideas of the middle ages, for example, and certain political conceptions of modern times; and, secondly, transient and changing ideas derived, to a certain extent perhaps, from the general ideas which arise and pass away in every age. Among these are the theories which guide art and literature at certain periods, such as those which have produced romanticism, naturalism, mysticism, etc. They are usually as superficial as the fashion, and change like it. They may be compared to the minor waves that are continually rising and vanishing on the surface of a river, while the fundamental ideas may be compared to the deep current that bears away the waters of the same river. Of the various transient ideas that arise in the course of ages, a few become in time fundamental directing ideas, but this is the result of rare combinations of special conditions.

It is as impossible to name the real creator of a great idea as to point out the author of a great invention. When an idea reaches the light and becomes capable of exercising influence, it is, like one of the great inventions, the sum of numerous anterior minor ideas. It has been subjected to long elaboration and numerous transformations. The originators of the idea are therefore far anterior to its propagators. The brains which conceived it live in regions inaccessible to the multitude. The results of their thought may exercise a considerable influence in the world, but they will not see it. If they were privileged to witness its development, they would not be likely to recognize the fruit of their meditations. From the intellectual heights whence the idea usually is derived, it comes down step by step, undergoing continual changes and modifications, till it takes on a shape accessible to the popular mind, when its triumph is assured. It then presents itself concentrated into a very small number of words, perhaps into only one, but that word evokes striking images, and consequently always impressive, whether they be seductive or terrible. Such were paradise and hell in the middle ages, short words that have the power of answering for everything, and to simple minds explaining everything. The word socialism repre-

sents to the modern workman one of these magical and synthetic formulas capable of ruling the mind.

We may discuss the value of an idea from a philosophical point of view; but from the point of view of its influence such discussion is without interest. The thing to be determined is not its value, but the action it exerts upon minds. In scientific affairs, the idea may have in itself a value independent of the time when it originated, and may preserve it beyond that time. In questions of institutions, creeds, morals, and government, the idea never having any but a relative value, its success depends primarily on the enthusiasm it inspires, and secondarily on the race and epoch in which it originated. Christianity could never have propagated itself till a particular epoch and among particular peoples. When the idea represented by the word Cæsarism dawned upon the Roman world, it had become necessary, because it survived its creator and every one of the persons who took his place, notwithstanding most of them died violent deaths. Two or three centuries earlier every effort to carry out such an idea would have miscarried. In this age representative governments, which are strongly rooted among some of the peoples of Europe, could not subsist among others.

The absolute truth of an idea is not, therefore, the thing to be considered. The value of an idea is measured by its success, its utility, or its danger, and these elements depend upon circumstances, media, and races. Only experience can demonstrate whether an idea is opportune. The notion of national unity, which is fundamental in modern politics, is very old, for Charlemagne tried to put it in operation. It could not be carried into the domain of facts, and the work of the great man perished with him. The idea of absolute religious submission to a representative of divinity, residing in the capital of Christianity, was for a long time an excellent one, but there came a time when, in the face of the advance of knowledge, it was no longer acceptable, and Philip II exhausted the force of his genius and the might of Spain, then predominant, in vain contentions with the spirit of free inquiry, which was then prevailing in Europe under the name of the Reformation.

The power of ideas, once fixed in the mind, is so great that no person is able to arrest their progress. Their evolutions must then inevitably be carried out, and all their consequences suffered. Most frequently, as with the socialists of the present time, their defenders are the ones marked to become their first victims. They are no better than sheep which docilely follow their leader to the slaughterhouse. We have to bow to the power of the idea. When it has reached a certain period of its evolution, no reasoning or demonstration can prevail against it. Centuries or

violent revolutions—sometimes both—are required to free peoples from the yoke of a dominant idea.

Ideas are propagated in the minds of the multitude chiefly through affirmation, repetition, prestige, contagion, and faith. Reason does not come within the enumeration, its influence in the matter being substantially null.

Affirmation, pure and simple, without reasoning and without proof, is one of the surest means of planting an idea in the popular mind. The more concise it is, the more free from every appearance of proofs and demonstration, the more authority it has. The religious books and the codes of all ages have always proceeded by simple affirmation. Statesmen called upon to defend any political cause and manufacturers advertising their goods know what it is worth. Yet it has no real influence, except it is constantly repeated, and, so far as possible, in the same terms. Napoleon said that repetition was the only serious figure in rhetoric. By repetition an affirmation is incrusted in the minds of hearers till they at last accept it as a demonstrated truth. What is called the current of opinion is formed, and then the potent mechanism of contagion comes in. Ideas that have reached a certain stage, in fact, possess a contagious power as intense as that of microbes. Not fear and courage only are contagious; ideas are, too, on condition that they are repeated often enough.

When the mechanism of contagion has begun to work, the idea enters upon the phase that leads to success. Opinion, which repelled it at first, ends by tolerating and then accepting it. The idea henceforward gains a penetrating and subtle force which sends it onward, while at the same time creating a sort of special atmosphere, a general way of thinking. Like the fine road dust which penetrates everywhere, the idea becomes general, and insinuates itself into all the conceptions and all the productions of an epoch. It then forms a part of that compact stock of hereditary commonplaces, of ready-made judgments, which are registered in books and imposed upon us by education. The final factor that gives the idea thus developed and spread its immense power is that mysterious force it acquires called prestige. Everything that rules in the world, whether of ideas or men, imposes itself principally through the irresistible force expressed by this word. It is a term which, while we comprehend the full meaning of it, is applied in too various fashions to be easily defined. Prestige comports with such feelings as admiration or fear, and is sometimes even based upon them, but it can easily exist without them. There are dead persons, and consequently beings we need not fear, like Alexander, Cæsar, Buddha, and Mohammed, who possess the highest degree of prestige; and there are other beings or fictions which we do not admire at all—like the monstrous

divinities of the subterranean temples of India—which appear to us invested with it.

Prestige is a kind of domination exercised over our minds which paralyzes all our critical faculties and fills our hearts with astonishment and respect. The feeling provoked by it is, like all our feelings, inexplicable, but it is probably of similar order to the fascination experienced by a magnetized subject. It is the strongest moving spring of all domination. The gods, kings, and women would never have reigned without it. Many factors enter into its genesis, of which one of the most important is always success. Every man who succeeds, every idea which prevails, cease by that fact to be disputed; and when success ceases, prestige vanishes with it. The hero applauded by the multitude in the evening is spat upon in the morning if his fortune has failed him; and the reaction is quicker in proportion as the prestige has been more brilliant. Prestige likewise tends to disappear under the light of discussion. One must hold the multitude at a distance to keep their respect.

The details of the psychology of prestige may be studied by setting them at the end of a series that descends from the founders of religions and empires to the particular person who is trying to astonish his neighbors with a new coat or a decoration. Between the extreme terms of such a series we should place all the forms of prestige in the various elements of a civilization—in the sciences, arts, literature, etc.—when we shall see that it constitutes the fundamental element of persuasion. Whether consciously or not, the being, the idea, or the thing possessing prestige is imitated at once, and imposes on a whole generation certain ways of thinking and of expressing thought. The four fifths of modern painters who reproduce the faded colors and stiff attitudes of the primitive school hardly suspect that they are imitators. They believe they are sincere; yet if an eminent master had not revived this form of art, they would still have seen in it only the childish side. Those who, at the instance of another illustrious master, flood their canvases with violet shades, do not see any more violet in Nature than was seen fifty years ago, but they have been infected with the personal and special impression of a painter who, in spite of this eccentricity, was able to gain great prestige. Similar examples might be found in all the elements of civilization.

Thus, through repetition, contagion, and prestige, men of each age come to possess a fund of ideas of an average sort which render them like one another, and to such a point that when centuries have accumulated over them, we recognize, by their artistic, scientific, philosophical, and literary productions, the age in which they lived. It is true that we can not say that they absolutely copied one another, but that they had in common

modes of feeling and thinking conducive to productions strongly affiliated with one another. We have reason to felicitate ourselves that this is so, for it is precisely this interweaving of identical traditions, ideas, feelings, creeds, and ways of thinking that constitutes the spirit of a people. That spirit is stable in proportion as the texture is solid.

So far as we have as yet studied the imposition of the idea, we have found it existing only in the upper ranks of the nation. For it to descend to the lowest strata and be spread among them in such a way as really to influence the mob, the intervention is required of that sort of believers in it whose faith is so intense as to impel them to propagate it—apostles. Men of this kind are usually converts so fascinated by the new idea that everything else vanishes from their thoughts. They are recruited chiefly from among those nervous, excitable persons who live on the borders of madness. However absurd may be the idea they defend and the end they are pursuing, all reasoning is blunt against their conviction. Despite and persecutions do not touch them, but only excite them all the more. They sacrifice personal interest and family, and so annul the instinct of self-preservation as to seek martyrdom as their only recompense. The intensity of their zeal gives their words a great suggestive force. The multitude is always ready to listen to any strong-willed man who may impose himself upon it. Men in a throng lose all their will, and turn instinctively to one who has any. An assembly of men is capable of acting only when it has a leader at its head.

The peoples have never had any lack of such leaders; but it is not necessary that they should all be actuated by the strong convictions that make apostles. They are more frequently subtle rhetoricians seeking personal interests alone, and trying to persuade by flattering base instincts. The influence they thus exert is usually very ephemeral. The great fanatics who have raised the spirits of mobs—Peter the Hermit, Luther, and Savanarola—did not exercise their peculiar fascination till they had themselves been fascinated by some belief. They could then create in souls that formidable power called faith, a still very mysterious force of which psychology afforded no explanation till it turned its investigations upon hypnotic phenomena, studied the unconscious transformation and combination of ideas into images and sensations, the doubling of the self, the coexistence of several personalities in the same individual, dying sensations, etc. Persons possessed by their faith may be compared to hypnotic subjects. They are, as it were, absolute slaves of their dream.

Whatever may be the real nature of faith, its power can not be contested. There is profound reason for the gospel affirmation that it can move mountains. The great events of history have

been brought about by obscure fanatics armed with nothing but their faith. The great religions which have governed the world and the vast empires that have extended from one hemisphere to the other were not built up by men of letters, of science, or by philosophers. The creed on which the civilization under which we live was founded was first spread by obscure fishermen of a Galilean market town. Shepherds from the Arabian deserts, whose contemporaries hardly knew of their existence, were the men who subjected a part of the Greco-Roman world to the dogmas of Mohammed, and founded one of the vastest empires known in history.

A strong conviction is so irresistible that only an equal conviction has any chance of struggling victoriously against it. Faith has no enemy to be really afraid of except faith. It is sure of triumph when the material force opposed to it is the servant of weak emotions and of weak belief. But if it is brought to face a faith of the same intensity, the contest becomes very active, and success is then determined by accessory circumstances usually also of a moral order, such as the spirit of discipline and better organization. In studying the history of the Arabians, to whom we have just alluded, we find that in their first conquests, which are the most difficult and the most important, they met morally weak adversaries. They first bore their arms into Syria. They found nothing more formidable than Byzantine armies composed of mercenaries with little disposition to sacrifice themselves for any cause. Inspired by an intense faith that multiplied their forces by ten, they dispersed these armies without ideas as in ancient days a little handful of Greeks sustained by love for their city scattered the innumerable hosts of Xerxes. Numerous examples in history stand in proof that when equally powerful moral forces meet, the best organized always carry the day.

In religion, as in politics, success always goes to believers, never to skeptics; and if the future threatens to belong to the socialists notwithstanding the annoying absurdity of their doctrines, it is because they are to-day the only persons who are really convinced. The modern directing classes have lost faith in everything. They do not believe in anything, not even in the possibility of defending themselves against the dangerous flood of barbarians all around them.

When, after a longer or shorter period of trials, transformations, discussion, and propaganda, an idea has acquired a definite form and has penetrated the spirit of the multitude, it constitutes a dogma, or one of those absolute verities which are not subject to discussion. It then forms a part of those general beliefs on which the existence of societies reposes. Its great characteristic is its immunity from discussion. When a new dogma is thus im-

planted in a people, it becomes the inspiration of its institutions, arts, and conduct. Its empire over the minds of the people is absolute. Men of action think of nothing else than of carrying it out and applying it; and philosophers, artists, and literary men occupy themselves with presenting it in various forms. Transient accessory ideas may arise from the fundamental idea, always bearing the impress of the one from which they issued. Egyptian civilization, European civilization in the middle ages, and the Mussulman civilization of the Arabs, were all derived from a very small number of religious ideas that put their mark on the most minute elements of those civilizations, and made them distinguishable at once.

In fact, the men of every age are surrounded by a network of traditions, customs, and opinions, created by their ideas, from the yoke of which they can not subtract themselves, and which make them very like one another. Men are more than anything else led, with a despotism which no tyrant ever exercised, by custom and opinion, which regulate the slightest actions of our existence, and from which the most independent man never thinks of extricating himself. Asiatic sovereigns are often represented as despots guided only by their fancies. These fancies are really confined within singularly narrow limits. The network of traditions and the yoke of opinions are especially strong in the East. Religious traditions, which have been loosened with us, retain all their empire there. The most self-sufficient despot would never strike at these two masters, which he knows are infinitely more powerful than he.—*Translated for The Popular Science Monthly from the Revue Scientifique.*

SKETCH OF CHARLES UPHAM SHEPARD.

CHARLES UPHAM SHEPARD was born at Little Compton, a town in the southeastern corner of Rhode Island, June 29, 1804. He was fitted for college in the Providence Grammar School and entered Brown University in 1820, but left the following year to join the sophomore class of the new college which opened then at Amherst, Mass. He was graduated in due course in the class of 1824.

In a graphic sketch of Amherst College as it was during his student days, contributed to Prof. Tyler's History, Prof. Shepard has said:

"I remember that I was the youngest of my class. Most of my fellows were mature youths who did not appear to me youths at all—seniors in character and manlike in purpose, with an air which seemed to tell of years of yearning for the ministry, and

of a brave struggle with the poverty which had kept them from their goal." After a description of the village and the mode of life in it, Prof. Shepard continues: "With such surroundings, what now were our interior advantages? Whatever we may have represented them to outsiders, whatever we may have persuaded ourselves concerning them, they were, in my day, extremely meager. The teachers were few, and in general were not distinguished in their departments. Our library did not surpass the scholarly range of a country clergyman in fair circumstances. Apparatus and collections were unknown in our first year, and they had made but feeble beginnings before our graduation. The only lectures which I remember were the two annual courses of Prof. Amos Eaton, in his day a distinguished botanist and geologist.

"In Dr. Moore, a gentleman of suave manners, of true Christain dignity, and of singular judgment in managing youth, we had an admirable president. I venture to suspect that he was the only college president in the United States who, from the beginning, personally subscribed for the somewhat expensive numbers of the Journal of the Royal Institution of London. From this source, and others similar, he appears to have gained a prevision of the importance of the modern sciences in education, and to him mainly are we indebted for the early foothold which they gained in the institution; to him, at all events, we owed the presence of Prof. Eaton. Rarely has college lecturer been more faithfully and enthusiastically listened to than Prof. Eaton in his courses on chemistry and botany, together with his abridged course on zoölogy. To supply the place of a text-book on the last-mentioned branch, he furnished us a highly useful printed syllabus, drawn mainly from the great work of Cuvier, then wholly inaccessible to us. . . . There were doubtless deficiencies to be regretted. In the larger and older universities we might have found better teachers and richer stores of libraries and collections, but in some unknown way, perhaps in the enthusiasm of comparatively solitary effort, compensation was made; and on the whole we may doubt whether higher life success would have attended us had we launched from other ports."

For a year after graduation he studied botany and mineralogy with Thomas Nuttall at Cambridge, and during most of this time taught the same branches in Boston. His study of mineralogy led to the preparation of papers on that subject which he sent to the American Journal of Science, and in this manner he became acquainted with its editor, the elder Silliman. He was invited in 1827 to become Prof. Silliman's assistant, and continued as such till 1831. For a year of this time he was Curator of Franklin Hall, an institution that was established by James Brewster in

New Haven for popular lectures on scientific subjects to mechanics.

In 1830 he was appointed to a lectureship in natural history at Yale, which he held till 1847. In the winter of 1832–'33 he investigated the culture of sugar cane and the manufacture of sugar in the Southern States, his results being incorporated in Prof. Silliman's report to the Secretary of the Treasury.

His investigation in the sugar States led to his appointment, in 1834, as Professor of Chemistry in the South Carolina Medical College, at Charleston. This position required his residence in the South for only part of the year, so that he was able to continue his lectures at Yale and to accept, in 1835, an appointment as associate to Dr. James G. Percival on the Geological Survey of Connecticut.

It was in the darkest hours of Amherst College, in December, 1844, that Prof. Edward Hitchcock was raised to the presidency of that institution, and in order to provide for the partial vacancy thus created in his department, Charles U. Shepard, of New Haven, was elected Professor of Chemistry and Natural History, this election "to take effect provided Prof. Hitchcock accepts the presidency." Both appointments were accepted. Prof. Shepard entered upon his new duties in the following year. Only two years were needed under President Hitchcock's able management to restore prosperity to the college. Prof. Shepard, being then satisfied that Amherst would be able to afford him a permanent field of labor, severed his connection with Yale and offered to bring his valuable collections to Amherst if the college would house them in a fireproof building and consider the purchase of them when it was able. This proposition was gladly accepted.

His professorship was divided in 1852, when the college became able to have a separate Professor of Chemistry. Prof. Shepard continued to deliver the lectures on natural history till 1877, when he was made professor emeritus. After leaving Amherst his northern home was at New Haven for the rest of his life.

The following history of the growth of Prof. Shepard's collections was written by him for the History of Amherst College, at the request of Dr. Tyler:

"My mineralogical cabinet was commenced at the age of fifteen, while a member of the Providence Grammar School, and was brought with me when I left Brown University to join the sophomore class of Amherst institution in 1821. An early visit after my arrival here to the tourmaline and other localities of Chesterfield and Goshen served to increase my eagerness as a collector, and at the same time placed me in possession of abun-

dant materials for exchange. In 1823 my identification of the previously supposed white augite of Goshen with the species spodumene, gave me confidence in the study of minerals, while it increased my stock of specimens desirable to mineralogists. The exchange I then carried on with the Austrian consul-general, Baron von Lederer, in behalf of his own collection and that of the Imperial Cabinet of Vienna, rapidly enriched my little museum in foreign minerals. Indeed, from the first it was sufficiently ample to serve a useful purpose in the instruction of beginners; and was the sole resource of Prof. Amos Eaton in the lectures he gave during two seasons before the students of the institution.

"On leaving college I resided a year partly in Cambridge and partly in Boston, during which period I profited much in extending my collections, through visits to new localities in eastern Massachusetts and Rhode Island, and still more by exchanges with Prof. Nuttall and other active cultivators of mineralogy in the region. I soon after made a very successful tour into Maine, where, at Paris, I was the fortunate discoverer of the most remarkable green and red tourmalines then known. With some of these I made profitable exchanges with the British Museum and other large collections. My association in 1828 with Prof. Silliman as his assistant, and afterward with the college as a lecturer on natural science for many years, afforded me unusual facilities for the extension of my cabinet. All the best localities of Connecticut were frequently visited, specimens of rare interest secured, and the means of supplying scientific correspondents abundantly obtained. These objects were still further effected by journeys into adjoining States and the Canadas, until 1835, when I became Professor of Chemistry in the Medical College of the State of South Carolina, where a new and very ample field was opened for the extension of my collections. From that time to the present [1871], with the exception of the period of the civil war, I have passed nearly the half of each year in the South, and been engaged to a considerable extent in scientific and mining explorations, which have resulted in varied and rich contributions to my cabinet. These travels have also embraced the Western or Mississippi States, attended by similar results. But most of all have I gained by frequent excursions to the Old World, having since 1839 twelve times visited Europe, where my exchanges and purchases of specimens have been conducted on a scale, I am led to believe, not surpassed by any of my countrymen. Numbers, however, have never been my aim in these acquisitions. I have rather sought what was characteristic and instructive—not, however, to the neglect of the rare and beautiful."

The foregoing relates to the mineralogical part of Prof. Shep-

ard's collections; his geological cabinet was also important, being especially remarkable for fossil remains. The meteoric collection, begun in 1828, he stated to be the fourth in extent and value known at the time of writing.

As to the transfer of the combined cabinets to Amherst College Prof. Shepard continues:

"The removal of these collections from New Haven to Amherst, in 1847, was the result of an understanding entered into between President Hitchcock and myself, that if the college would cause a fireproof building to be erected for their reception, I would deposit them therein, at least for a term of years, and with the hope, through arrangements afterward to be made, of leaving them with the college as a permanent possession. Such a building was provided in the Woods Cabinet; and, more recently, the conditions for the purchase of the collection have been agreed upon." When he wrote the above he was engaged in the more perfect cataloguing and arranging of the three collections.

When Walker Hall was built, the mineralogical cabinet was removed to rooms in that building, and was destroyed when the building was burned, in March, 1882. Although few could be classed as combustibles, a diligent search in the *débris* of the building revealed scarcely a trace of the specimens. This was a sad loss. Prof. Shepard valued the collection at seventy-five thousand dollars, and the college had actually paid forty thousand dollars for it. There was only fifteen thousand dollars of insurance on the whole contents of the building.

Dr. Shepard held his professorship at Charleston uninterruptedly until the civil war, and immediately after it closed he went back, at the urgent invitation of his former colleagues, and resumed his lectures. In 1869 he retired from the full discharge of his duties, but continued to give some lectures until shortly before his death. While in Charleston he discovered rich deposits of phosphate of lime in the immediate vicinity of that city. Their great value in agriculture and subsequent use in the manufacture of superphosphate fertilizers proved an important addition to the chemical industries of South Carolina.

The collection that was burned in 1882 was the finest in the United States, and was surpassed abroad only by that in the British Museum. But Dr. Shepard's collecting had not stopped with its formation, and he succeeded before his death in gathering a second cabinet of meteorolites and minerals which ranked among the very largest private collections. This he kept in a fireproof cabinet at his private residence in New Haven.

Prof. Shepard died, after a short illness, at Charleston, May 1, 1886.

In its obituary the Charleston News said of him: "He chose his profession well. A mind so analytic as his and so keen in the perception of relations could not have failed to see that the field in which he cast his literary fortunes was one which offered an undying reward for those who made it a successful arena of untiring and indomitable labor and energy. . . . Prof. Shepard discovered more new species of minerals which have attained permanent recognition than perhaps any other scientist of the present day. He was a member of many American and foreign societies, among which are the Imperial Society of Natural Science of St. Petersburg, the Royal Society of Göttingen, and the Society of Natural Sciences of Vienna. He published a Treatise on Mineralogy (1832 and 1835), a report on the Mineralogy of Connecticut, and numerous scientific papers." Many reports on mines made by him have been printed.

He announced in 1835 his discovery of his first new species of microlite, that of warwickite in 1838, that of danburite in 1839, and he afterward described many other new minerals until shortly before his death. His knowledge of minerals was wonderfully extensive, "and he was hence ready," it has been said, "with quick judgments as to new and old; sometimes too quick—but in any case imparting progress to American mineralogy."

The honorary degree of M. D. was conferred upon him by Dartmouth in 1836, and that of LL. D. by Amherst in 1857.

He was a man of refinement and great courtesy, and was held in high esteem wherever he resided.

He left two children, a son and a daughter.

Prof. Shepard's son, Charles Upham, was born at New Haven, October 4, 1842. He was graduated from Yale College in 1863, and took the degree of M. D. at Göttingen in 1867. He succeeded to his father's professorship at Charleston, and has been active in developing the phosphate and other chemical industries of South Carolina. In 1887 he presented the second cabinet of minerals that was formed by his father, numbering more than ten thousand specimens, to Amherst College, and his cabinet of representatives of more than two hundred different meteorites has been deposited in the United States National Museum.

SPECTROPHOTOGRAPHIC investigation by Prof. Keeler makes it certain that the rings of Saturn are not solid, but are composed of innumerable small bodies or meteorites. The observations show that the motion of the interior parts of the rings is more rapid than that of those of the outer part, which might be the case if the rings were composed of free moving bodies independent of one another; while if the rings were solid the outer parts would necessarily move the fastest.

EDITOR'S TABLE.

THE SPHERE OF SCIENCE.

WE publish in this number a criticism by a gentleman who, we understand, is connected with one of our most distinguished universities, of the article which appeared in these columns some months ago under the title of Back to Dogma. In that article we maintained that the then recent address of Lord Salisbury, as President of the British Association, was, to all intents and purposes, an appeal to the scientific world to put on once more those dogmatic shackles from which the philosophical advance of the present century was supposed to have set it free; and we endeavored to show how fatal to the further progress of scientific theory a compliance with such a suggestion would be. The author of the article we are now publishing seems to agree with us entirely that the general drift of the address was reactionary; but he considers that we go too far in another direction when we say that the reintroduction of the doctrine of design, as an explanation of things which challenge our curiosity, would mean "the death of scientific investigation."

If we have published this article we have done so—and we think it right to make the statement—less upon its merits as a piece of scientific or philosophical argumentation, than because we are anxious to give every opportunity for the free and fair criticism of opinions expressed in this journal. Science does not admit of any one-sided expositions; and it knows no orthodoxy save that which open discussion, free from all bias of self-interest and prejudice, may at any given moment appear to establish. It has always been the aim of this journal to convey to its readers the idea that science is not a rigid system of unalterable deductions, but consists essentially in the gradual adaptation of the thought of mankind to the ever-unfolding aspects and meanings of the universe. While holding our own views, therefore, of the questions which from time to time occupy the attention of the scientific world, we not only have no desire to exclude contrary expressions of opinion, but are entirely prepared to extend to them a cordial hospitality, provided they are stamped with a reasonable degree of logical force and adequacy. The address delivered by the Marquis of Salisbury was a case in point: we could not agree with its main positions, but neither could we deny that it was a highly plausible and, upon the whole, extremely able presentment of a view which formerly found multitudes of adherents, and still finds not a few. We therefore made a point of transferring it to our columns, while reserving the liberty to criticise it, as we did, in this portion of our journal. In the same spirit we publish Mr. Clark's article in which our criticism is called in question; and we have now to consider how far his objections to the position taken by us are valid.

As already mentioned, our critic agrees with us as to the reactionary character of Lord Salisbury's address. We expressed our sense of this by the heading we gave to our article Back to Dogma! and we hardly think it can be denied that if a reactionary movement takes place in the scientific world it must carry us back to dogma. That scientific investigation was formerly dominated by

dogma, our critic seems quite prepared to acknowledge. Indeed, he uses language which so fully agrees with our own that we almost wonder he thought it worth while to find fault with our position. We said that an acceptance of the doctrine of design would be the death of scientific investigation. Mr. Clark, speaking of the Darwinian doctrine of natural selection, says that for thirty-five years it has been "the mainspring of research not merely in biology, but in all the field of natural science." But the two doctrines are completely opposed: so that what Mr. Clark says of the one is virtually a confirmation of what we said of the other. Take away or break "the mainspring of research," and what would follow? If the metaphor is sound, arrest of movement would follow; and what is arrest of movement but death, for the time being at least? Before Darwin's time, our critic says, "naturalists were content with statistics, and did not ask for reasons." And he adds, "that this was due to a belief in the immutability of species and the doctrine of design there can be little doubt." And yet, because we said what we did about the doctrine of design, we are accused of displaying "illogical reasoning and uncalled-for prejudice"!

At this point Mr. Clark gives a little twist to our words which does not speak well for his candor or his carefulness: let us trust that it was the latter that was at fault. We said that "the reason why the doctrine of design is so *popular*" is, partly because it is such a saver of intellectual toil, and partly because by making knowledge impossible it glorifies ignorance." Our critic, referring to this remark, says that to accuse "the great men who accepted that doctrine" in pre-Darwinian times of having done so for the reasons mentioned, "is a gross slander." Well, as we were speaking of what made the doctrine "popular" in the present day, and said nothing whatever about the great men of the past, who had hardly any choice in the matter, the "gross slander" exists only in Mr. Clark's imagination—a faculty which a man of science, such as he professes to be, should learn to keep in subjection.

Our critic finds that the very success of the doctrine of evolution has brought in a new danger. These are his words: "The doctrine of evolution has proved so satisfactory at every turn, that there is great danger that the ultimate motive for scientific research will be completely lost to sight." That motive he declares to be expressed in the interrogation "Why?" The older naturalists set themselves to answer the question "What?" In other words, they sought out and classified facts. Darwin came on the scene with the question "How?" and his answer thereto. And now Mr. Clark steps forward with the question "Why?" to which he hopes an answer will some day be forthcoming. He is not content to understand the processes of becoming; he wants to know what objects God has in view in causing things to happen as they do. That he declares to be the true motive for scientific research, without which it is a matter of "mere curiosity." As to the possibility of attaining to a knowledge of the why, he considers, rather oddly, that the success of the doctrine of evolution in answering the question How? should give us great encouragement. "Is not," he argues, "the doctrine of evolution becoming less and less of an hypothesis and more and more of an actually established law every year? Is not the evidence all tending to establish it completely, and to prove that even the obscure problems of life

and heredity are all within the limits of human knowledge? Can we then be sure that the knowledge of *why* evolution has worked as it has is unattainable?"

It is really somewhat lamentable that a man who has evidently had some training in science, and who perhaps either is, or is about to become, a teacher of it, should reason in this way. Because a certain line of inquiry, dealing with natural causes, has proved eminently fruitful, therefore we may—such is the argument—reasonably suppose that another line of inquiry, dealing not with natural causes at all, but with the supposed motives of an Absolute Being, will also prove fruitful. When will our institutions of learning knock a little common logic into the heads of their graduates, so that they shall not be at the mercy of the first idle and misleading analogy that happens to flit through their brains? We should like to know whether Mr. Clark has ever tried to form any clear idea of what he means by attaining to a knowledge of the why—what, exactly, it would be like to see into the mind of a Divine Being, and acquire an understanding of his thoughts and purposes. Straining his imagination to the utmost, can he give us any hint as to the steps by which such knowledge as he aims at could be approached? In all the ages that have passed, has the smallest commencement been made toward an insight into the "Why"? The religions of the past have all, in their manner, grappled with the question, but with what result? Absolutely none. We know no more on this subject than our ancestors of a hundred generations ago; but we differ a little from our ancestors in being more content than they to abide in a necessary ignorance. We find, moreover, that a knowledge of the How renders in many cases a knowledge of the Why not only unnecessary but inconceivable—renders the very idea of such knowledge absurd. When we have once grasped the law of gravitation in its application to the solar system, do we feel any special need to ask *why* it was arranged that the attraction exerted by the sun and the planets upon one another should be directly as mass and inversely as distance? When we learn the properties of oxygen, hydrogen, and nitrogen, do we feel as if we must also know *why* they are endowed with such properties? When we see how running water sifts earthy materials, how the action of the waves furrows the sand, wears away rocks, and smooths pebbles, do we exclaim, "But why? oh, why?" When we study the laws of mechanics and grasp the simple formulas which express the action of the lever, the screw, and the inclined plane, do we feel that it would elevate us greatly in the scale of being to know *why* these things are so? It may be said, perhaps, that these are not the phenomena which suggest the question Why? If so, we reply that if we would know the true nature of that question we must apply it to such matters as these. Applied to these, we see that it is a silly and meaningless question; but none the less is it silly and meaningless when applied to other matters. Men want to know why a pestilence or famine was *sent* (as they say) at a particular time; they do not trouble themselves with the prior question whether it was *sent* at all in any proper meaning of the word. What we know is that sanitary science is showing an admirable power of controlling pestilences, and that famines only occur where there is defective knowledge and inferior social organization. Here again, therefore, a knowledge of the cause renders

any inquiry into the why absolutely idle.

The highest motive for scientific research we hold—in opposition to our critic—to be the improvement of the conditions of human life. That there are, in our day, adequate motives for research is evident from the advances which science is making in every department; and that such advances are possible is due to the fact that men have, for some generations, been mainly seeking answers to the question "How?" Were they now to betake themselves to the question which Mr. Clark commends to the attention of the scientific world, the result would be a disastrous arrest of progress. In the ages when pestilences were of frequent occurrence, all the conjecturing that men could do as to *why they were sent* did not avail one jot to check their virulence. The knowledge that was needed, we see clearly now, was the knowledge of *how they were caused*. If that could have been got through the wool of our ancestors, their sufferings would have been wonderfully abated. And to-day, as then, the knowledge that is most needful is the knowledge of causes. Take away from us our knowledge of causes, and all that we could conjecture of Divine purposes would not save us from plunging into barbarism.

PROFESSOR HUXLEY.

By the death of Professor Huxley the world has lost a man whom it could ill spare. He was one of the very few men who unite to a real capacity for original work the impulse and the ability to bring home the results of scientific research to the popular mind. He believed that a knowledge of science, and above all of scientific method, was good for mankind; and he turned aside from studies in which he had won renown, and might have won more, in order that he might preach what he considered the gospel of science to the multitude. Some of his friends regretted this; in the interest of his fame they would have preferred that he should never have quitted the higher walks of scientific investigation; but for our own part it seems to us impossible that Huxley should have chosen his course otherwise than as he did. He had, what few of the devotees of pure science possess, strong popular sympathies and an extremely active temperament. He could not so immerse himself in the minutiæ of anatomy, or the obscurities of physiological processes, as to be indifferent to what was going on in the world around him. He was interested in fishes and reptiles, but he was more interested in his fellow-men; and it would be difficult to overestimate the value of the service he rendered in promoting sound habits of thought in this generation. Having won complete intellectual emancipation for himself, he desired that others should share the same benefit; and wherever the cause of intellectual liberty seemed to be in danger, there he was ready to come forward in its defense.

No one could read a page of Professor Huxley's writings without being struck by the breadth of culture they displayed. He was not a university-bred man, and yet in his knowledge of literature and philosophy—to say nothing of his strictly scientific attainments—he put the vast majority of university men to shame. His culture, however, was never merely on exhibition as culture; it was employed in the most legitimate manner to strengthen the causes he had at heart. There was in him too broad a humanity and too much of earnest purpose to permit him to lapse into the arts of the

rhetorician. Not often indeed has such a combination of gifts been seen in one writer; and, now that he has gone from us, it is a supreme satisfaction to reflect how nobly these gifts were used, how sincerely and courageously and untiringly they were devoted to the good of mankind. The world is poorer by the death of Huxley; but the greatest must pass sooner or later from the stage of existence, and, as they pass, the lesson of their lives comes out with greater distinctness. Of Huxley we may truly say that he enriched the life of our time by his thought and by his example, and that the forces which to-day make for progress in the world are better organized for victory, and move forward with steadier hope, through the help and inspiration which he afforded.

HONOR NOT HONORS.

WHEN it was announced a short time ago that the Emperor of Germany had bestowed a knighthood of the "Ordre pour le Mérite" upon Mr. Herbert Spencer, many of the friends and admirers of the philosopher thought that possibly this had been done with his concurrence, and that in this case he had made an exception to his general practice of declining all such decorations. It seems, however, that such is not the fact. Mr. Spencer was not aware that any such recognition of his eminence as a thinker and writer was in contemplation; and when the offer was made to him he courteously and respectfully declined it. The question has sometimes been asked by persons of a shallow way of thinking how it is, if Mr. Spencer is really a philosopher of mark, that the title-pages of his books do not show the academic and other distinctions that he has received. The answer has been given more than once; but we may as well take advantage of the present incident to give it once more: that such distinctions have over and over again been offered to Mr. Spencer, but that he has made an invariable rule of declining them. Whether he has been altogether wise in this is a matter on which opinions may differ; but his motive, so far as we understand it, seems to be unquestionably sound. He does not wish to appeal to the world with any prestige borrowed from the approval of universities, academies, or constituted authorities of any kind. He wishes his works to be judged on their own merits, pure and simple, quite apart from the glamour which the possession of honorary degrees and membership in so-called learned societies is prone to shed. In the case of the German "Ordre pour le Mérite" it is stated, and we believe with truth, that Mr. Spencer had a special objection to the idea of receiving distinction from the hand of the autocratic head of the most military nation of modern times. In his mind militarism is associated with all that is retrograde and tyrannical; he holds it to be the chief influence which to-day retards the development of society; and we can well understand therefore that, apart from his general objection to official decorations of all kinds, he would feel compelled, on grounds of consistency, to decline an honor which would have brought him into a kind of personal relation with a system of government he totally disapproved.

To sum up Mr. Spencer's position, he writes for mankind at large, not for powers or principalities, for courts or for coteries. If his labors bring him the honor of his fellow-men, that is the highest reward he craves; to *honors* as commonly understood he is indifferent. He is the "Great Com-

moner" of philosophy, and without the aid of titles sways the thought of the world more potently than any other man of this generation.

LITERARY NOTICES.

PHYSICS FOR UNIVERSITY STUDENTS. By HENRY S. CARHART, LL. D. Boston: Allyn & Bacon. Pp. 335.

THIS is Part I, including mechanics light, and sound, of a text-book, not a treatise, the necessity for which has grown out of the author's own needs as a teacher. The book does not pretend to cover the subject, nor to treat exhaustively those portions with which it deals. It has been written with the notion of giving the student a general survey, and only those portions of the science of most importance from this standpoint have been selected for treatment. Rather more space than is usual in an elementary book is given to a consideration of simple harmonic motion. The author explains this by pointing out its value in the study of alternating currents of electricity and in mechanics. After the statement and explanation of the various laws, the author has arranged problems for testing the student's knowledge. The following, which is one of the experiments given to illustrate surface tension, will convey a fair notion of the simplicity and clearness of the author's style: "Make a ring of stout wire three or four inches in diameter, with a handle. Tie to this a loop of thread so that the loop may hang near the middle of the ring. Dip the ring into a good soap solution containing glycerin, and obtain a plain film. The thread will float in it. Break the film inside the loop with a warm pointed wire, and the loop will spring out into a circle. The tension of the film attached to the thread pulls it out equally in all directions."

ELECTRICITY AND MAGNETISM. By S. R. BOTTONE. London and New York: Whittaker & Co. Pp. 203. Price, 90 cents.

PROF. BOTTONE, who is the author of several other books on electrical subjects, has here presented in small compass and popular form an outline of what is known about electricity. "The work is not intended as a text-book," he says in his preface, "hence no recondite calculations and no mere enumeration of all the existing electro-magnetic appliances are introduced. . . . The two old theories are sufficiently dwelt upon to enable the reader to form an intelligent conception of them, while very special stress has been laid upon the modern and more satisfactory 'molecular' theory." The book has evidently been prepared for adult readers, as its language is not restricted to the vocabulary of the young. There are one hundred and two illustrations.

THE RISE AND DEVELOPMENT OF ORGANIC CHEMISTRY. By the late CARL SCHORLEMMER, LL. D., F. R. S. Revised edition. Edited by ARTHUR SMITHELLS, B. Sc. London and New York: Macmillan & Co. Pp. xxvii + 280. Price, $1.60.

MUCH light is thrown upon any science by tracing the successive discoveries through which it has been built up. There is a chance also to give such a story an attractiveness which a general treatise on the subject might never hope to possess. Prof. Schorlemmer well improved this opportunity, and one who has any knowledge of chemistry will be interested in his account, telling when and by whom the principal advances in this field have been made, and pointing out the importance of each and its bearing upon the state of the science at the time. The vivacious movement of the author's style and his occasional anecdotes relieve the book from the dryness that might be thought inseparable from it. The volume first appeared some years ago, and the present edition has been revised partly by the author and partly since his death by Prof. Smithells, who has prefixed a biographical notice of Prof. Schorlemmer. There is also a frontispiece portrait of the author.

HOW TO MAKE AND USE THE TELEPHONE. By GEORGE H. CARY, A. M. Lynn, Mass.: Bubier Publishing Co. Pp. 117. Price, $1.

THIS is a little workshop companion, confining itself entirely to the practical parts of the subject: the materials and simplest methods of construction; the parts most liable to get out of order, and how to discover and repair them; the things *not* to

do in handling the instruments; the simplest and most reliable batteries, etc. That the book is a really practical one may be gathered from the following extract: "The poles for an ordinary line to carry from one to four wires should be of chestnut, cedar, or other durable wood, and should be reasonably straight, at least twenty-five feet long, and at least five inches in diameter at the top," etc. An appendix contains a chapter on the Gibboney long-distance telephone, and another on how to make the phonograph.

A Florida Sketch-book. By Bradford Torrey. Boston: Houghton, Mifflin & Co. Pp. 242. Price, $1.50.

As a writer of out-of-door books Mr. Torrey must be given high rank. His style is chatty, he goes into no long disquisitions, and in his descriptions of Nature he does not forget that the human animal is part and parcel thereof. His favorite subjects of observation are birds, and he tells us much about the ways of the herons, the pelicans, and the gannets, of the kingfishers, the grackles, and the buzzards, and many others of the feathered tribe. Occasionally he tells us about creatures of other kinds, or some striking flower, and his experiences with crackers and negroes are frequent enough to give quite a human flavor to the book. A curious bit of local language here and there adds still further to the variety of his observations. The value of the little volume is increased by a serviceable index.

The Story of the Stars. By George F. Chambers, F. R. A. S. New York: D. Appleton & Co. Pp. 160. Price, 40 cents.

Ignorance of Nature can no longer be excused by the size and forbidding character of scientific books. An especially attractive series of little guides to various divisions of the world about us has begun to appear under the general title of The Library of Useful Stories, the first place in the series being given to the stars. Mr. Chambers is an experienced writer on astronomical subjects, and has a happy faculty for taking away the strangeness of unfamiliar things. He opens this little volume by telling of two legal cases which turned on the matter of standard time, and shows that in such matters, as well as in navigation, astronomy comes very close to everyday life. This, followed by a chapter on First Experiences of a Starlight Night, make an easy introduction to the subject. In speaking of the constellations and their history he improves the opportunity to bring in much curious lore. Of similar interest is the chapter on The Stars in Poetry, further along. Every one has wondered about the number of the stars, and Mr. Chambers does not neglect to tell us what attempts have been made to estimate them. Colored, moving, temporary, and variable stars are duly described; also stars arranged by twos, in groups, and in clusters. The nebulæ and the Milky Way have due consideration, and finally we are told something of what has been learned by the spectroscope about the stars and nebulæ. A Table of the Constellations and a List of Celestial Objects for Small Telescopes are appended. Twenty-four maps in white on black illustrate the text.

A Standard Dictionary of the English Language. Vol. II, M–Z and Appendix. Edited by Isaac K. Funk, D. D., Editor in Chief; Francis A. March, LL. D., L. H. D., Consulting Editor; and Daniel S. Gregory, D. D., Managing Editor. New York: Funk & Wagnalls Co. Pp. 1061–2318. Price (of two-volume edition, complete), russia, $17; morocco, $22.

A little over a year ago we pointed out the chief distinguishing features of this work in noticing its first volume. In the second volume the excellences of the first are well maintained. Among the special features falling in the latter half of the alphabet are colored plates showing national coats of arms, familiar flowering plants, signal flags, and typical colors, also plates showing typical heads of human races, and the seals of the United States, the several States, and the Territories. Several other terms have illustrations occupying a whole page. The color chart appears under "spectrum" and is accompanied by a table giving the percentages of primary colors to be combined for producing nearly five hundred shades. A list of varieties, subdivisions, or technical terms is given under many words, such as man, measure, officer, printing-press, science, soap, theology, watch,

and weight. The appendix includes a collection of names in biography, fiction, geography, mythology, etc., with the pronunciation and definition of each, arranged in a single alphabetical list. There are also a glossary of foreign words and phrases, a list of cases of faulty diction, lists of disputed spellings and pronunciations, abbreviations, signs, and one giving the sentiments of flowers and gems. The scientific alphabet used throughout the dictionary to indicate pronunciation is explained at length in the appendix, and there is also a key showing the pronunciation of Anglo-Saxon, Latin, Greek, and thirteen modern languages with the aid of this alphabet. In the appendix, as in the body of the work, the form and arrangement of the matter have been carefully adapted to popular use. In a great many families the dictionary is the only reference book, and to these especially the Standard will prove highly satisfactory.

DR. JUDAS: A PORTRAYAL OF THE OPIUM HABIT. By WILLIAM ROSSER COBBE. Chicago: S. C. Griggs & Co. Pp. 320. Price, $1.50.

NINE years of dreadful experience joined to the facile diction of an able journalist are here applied to warning all who will read of the horrors of opium slavery. The author tells the story of his own subjection—vividly, impressively, fascinatingly—with incidents from the experience of others and observations on the effects of other narcotic drugs. The habit was fastened upon him from the administration of morphine during an illness by his physician. He declares that a great majority of the two million persons habitually using narcotic drugs in the United States were introduced to the habit by careless physicians, whom he censures severely. From the start he found himself compelled to deceive and lie in order to conceal the practice. For this he despised himself, and he was also in constant dread of being found out. Delusions as to hostile intentions of those about him and threatening voices haunted him. The unsettling influence of the drug caused him to endanger the support of his family several times by giving up his position. He had bewildering, grotesque, and dreadful dreams, and among his other ills were insomnia, periods of depression, and a variety of aches and pains. After many attempts to break his chains, he was cured by a treatment lasting thirty days, thus contradicting the verdict of many physicians that "the opium habit is a vice which can not be reached by medical science." The author vigorously denounces De Quincey's book, and contradicts many of its statements which are favorable to opium.

ELEMENTARY LESSONS IN ELECTRICITY AND MAGNETISM. By SILVANUS P. THOMPSON. London and New York: Macmillan & Co. Pp. 607. Price, $1.40.

THIS is a new and revised edition of a work which first appeared in 1881. The revision was rendered necessary by the large advances which have been made in the electrical world during the last ten years. These advances have occurred not alone in the practical electrician's department, in the way of perfecting old and creating new machinery and thus opening new fields for its application, but also in the general acceptance and extending of theories which ten years ago were mere speculations.

The most striking of the latter has been the establishment of the identity between light waves and electrical waves, a fact the probability of which Clerk Maxwell suggested many years ago, and which has since been practically established by the work of Heinrich Hertz. In view of the widespread and constantly growing uses and applications of electrical energy in the arts and in transportation, it seems quite essential that even a common-school education, to which, unfortunately, much the greater number are limited, should include such a study of electrical theory and practice as would, at any rate, teach the student the dangers and means of guarding against accident when in the neighborhood of this most subtle and silent of workers. This book, while rather more extensive than such a superficial knowledge would require, is simply and clearly written and well arranged, and, as its name implies, begins at the bottom.

The first three chapters have to do respectively with frictional electricity, current electricity, and magnetism, and together constitute Part I. Part II contains chapters on electrostatics, electro-magnetics, electricity as a heating, lighting, and motor

agent, electro-chemistry, telegraphy, telephony, and electric waves. There is an appendix containing tables and various practical points, such as "directions for setting up a cell," etc. This is followed by a number of carefully prepared problems for school use. There is a magnetic chart of the British Islands and other illustrations.

THE CAT: A GUIDE TO THE CLASSIFICATION AND VARIETIES OF CATS, AND A SHORT TREATISE UPON THEIR DISEASES AND TREATMENT. By RUSH SHIPPEN HUIDEKOPER, M. D. New York: D. Appleton & Co. Pp. 148. Price, $1.

THE first national cat show, held in New York in the early part of May of the present year, may be regarded as opening a new era in the life of Pussy in this country; and we may henceforth expect to have cat fanciers and cat breeders and the other appurtenances of a well-cultivated and really proper fad, as we have long had horse and dog fanciers and breeders. In view of her independence and individuality, it is well that Pussy be taken up and have more regard paid to her than heretofore. When it became certain that the exhibition would be held, and inquiries were made concerning the classification and qualities, it appeared that New York had no suitable book on the subject. Dr. Huidekoper perceived the emergency, and determined to supply the want. He has done it very well. The book is a practical one, as well as scientific. It treats of the zoölogical position of the cat family, the anatomy, origin, and varieties of the domestic cat, classified as long-haired and short-haired; the care of the cat; its diseases and the remedies, the etymology and synonyms, and the emblematic significance of the animal.

ELECTRIC LIGHT CABLES AND THE DISTRIBUTION OF ELECTRICITY. By STUART A. RUSSELL. With 107 Illustrations. London and New York: Whittaker & Co. Pp. 319. Price, $2.25.

THIS is to be one of the new series of books for students, practical engineers, and others, to be called The Specialists' Series. It is thoroughly practical, describing the primary systems of distribution and their combinations, the various forms of conductors and the insulating materials in use, modes of placing overhead and underground lines, internal wiring, modes of testing, etc. Among the problems discussed are the relative advantages of different materials for conductors, the relative economy of direct and transformer systems, the use of air insulation, and the comparative advantages and disadvantages of overhead and underground lines. Besides presenting the results of experience so far attained, the book has the additional purpose of helping the further advance of knowledge in its field.

GEOLOGICAL SURVEY OF NEW JERSEY. REPORT ON WATER SUPPLY, WATER POWER, THE FLOW OF STREAMS, AND ATTENDANT PHENOMENA. By C. C. VERMEULE. Pp. 352 + 96.

THE present is Volume III of the final report of the State Geologist. The waters of the State having been recognized by the Geological Survey as part of its mineral resources, much attention has been given to them in nearly all the reports. The subterranean as well as the accessible waters were studied by Mr. Cook, the late State Geologist, as to their accessibility, volume, and character, and the artesian wells along the Atlantic coast belt have demonstrated the accuracy of his studies. The work for the present volume was begun in 1890. Results of permanent value have been obtained, illustrating, among other points, the large influence of geological conditions upon storage and delivery of ground water; the bearing of evaporation and ground storage upon stream-flow; the preponderating influence of temperature in determining the amount of evaporation and the total run-off of streams for a given rainfall; the subordinate influence exerted by forests and other vegetation thereon; and the indicated certainty of occasional periods of small rainfall. The former part of the volume is occupied with discussion of the laws that govern stream-flow, rainfall, evaporation, ground storage, surface storage, and surface or flood flows. Gauging flows and the method of computing them are next considered. The local water systems are then described. The latter part of the book is devoted to generalizations as to water supply, chemical analyses, public water supplies, water power, evaporation, ground storage, effects of vegetation,

and stream-flow; and a list of the developed water powers and the drainage systems is given in the appendix.

The Psychology of Childhood, by *Frederick Tracy* (Heath, 90 cents), would be better described by the title The Psychology of Infancy, for the view which it affords extends but little beyond the first two years of life. The author shows that he recognizes this fact, so perhaps the publisher is responsible for the title used. What is here undertaken is "to gather together, so far as possible, the best work that has been done in actual observation of children up to the present time, arrange this under appropriate headings, incorporate the results of several observations made by the writer himself, and present the whole in epitomized form, with copious references and quotations." The mental manifestations of early childhood are taken up in the following order: sensation, emotion, intellect, and volition. Language, in view of its peculiar importance, is treated in a chapter by itself. Prof. G. Stanley Hall testifies in an introduction to the thoroughness with which the work has been done.

The doctrine set forth by *Theodore C. Knauff*, in his *Athletics for Physical Culture*, is that gymnastics is good, but athletic sports are better. (Tait, $2.) Accordingly, after giving two short chapters to gymnasium work, he describes nearly a score of athletic games and contests, pointing out their valuable features and warning against their dangers. His descriptions are general, not aiming to give the technics of the sports treated. Other subjects discussed are Training, Questions of Hygiene, Athletic Clubs, and Professionalism. There is a special chapter on Women in Athletics, in which the matter of dress is prominent, and in the chapter on Equestrianism the riding of women receives separate attention, the cross-saddle position being strongly advocated. The volume contains a large number of instructive illustrations, most of them made from photographs.

The Twenty-second Annual Report of the Geological and Natural History Survey of Minnesota is a record of the regular work of the survey in 1893. *The Twenty-third Annual Report* is largely made up of discussions on interesting general and economic topics. In the first of these the origin of Archæan greenstones is treated by N. H. Winchell, the State Geologist. This is followed by a preliminary report on the gold region about Rainy Lake, by H. V. Winchell and U. S. Grant, and a record of the mineral discoveries in the Lake Superior region, which includes the Mesabi iron deposit. Another scientific topic considered is the late glacial subsidence and re-elevation of the St. Lawrence River basin.

The *Journey through Mongolia and Tibet in 1891 and 1892*, of which Mr. *William Woodville Rockhill* gives the story in a large and handsomely illustrated volume, was undertaken by him partly under the auspices of the Smithsonian Institution, and the work is issued as one of its special publications Tibet is now, as it has been many scores of years, the most isolated country in the world. Many travelers have attempted to reach its interior, but all have been turned away when they came within a certain distance of the capital. Mr. Rockhill himself was brought to a stop in the neighborhood of the Tengri nor and the Gart'ok. Although his route was not to any great extent through wholly new country, he has been able, through his knowledge of the Chinese and Tibetan languages, as well as by his own observations, to collect many data of interest and value. At any rate he has given us a very excellent book concerning a region of which very little is known.

The *Revue Franco-Américaine* is a new French magazine, especially designed for American readers; and with that view it promises to temper the freedom with which French writers are sometimes accustomed to express themselves, to suit American ideas of propriety and taste. It is edited in Paris, by Prince Poniatowski; will admit only masters of French literature and the principal artists of France (though we find Whistler named among them) as contributors; will give representation to the various schools of art and literature; and will "not be composed of extended, heavy studies, but will contain short, vivid, vigorous articles on subjects of universal interest." The first number, of one hundred and twenty-three pages, contains many articles of the character described, by well-known authors, with portraits of French authors in their work-

rooms, and other pictures that deserve to be well spoken of. (83 and 85 Duane Street, New York; price, $10 a year.)

The microbe has, during the past few years, assumed so prominent a place, both in dietetics and therapeutics, that nowadays a medical school of any standing must include in its curriculum, some sort of a course in bacteriology. The book before us, *A Course of Elementary Practical Bacteriology*, by *A. A. Kanthack*, M. D., and *J. H. Drysdale*, M. B., has grown out of the teacher's and student's needs at the St. Bartholomew Hospital in London, and is designed simply as a laboratory handbook. It is arranged in three parts. Parts I and II, Elementary Bacteriology and Bacteriological Analysis, encompass three months' work. The third part consists of an introduction to bacteriological chemistry. (Macmillan, $1.10.)

A Report on the Geology of the Coastal Plain of Alabama has been issued by the Survey of that State. The coastal plain includes all but the northeastern two fifths of the State. It is an agricultural region, and contains only such useful minerals as fertilizers and building materials. It is interesting scientifically from the remarkably complete series of Eocene and Cretaceous strata exposed in its river banks.

The piece of special pleading for Greek in which *John Kennedy* essays to answer the question *Must Greek go?* is likely to be ineffective because of its extravagance (Bardeen, 50 cents). The author claims for Greek the excellence of Shakespeare, Burns, and Keats, to whom Greek culture was accessible only at second hand, also the "Spirit of '76" and the beauty of the Columbian Exposition, allowing no credit to our inheritance from our Germanic ancestors. His claims are tricked out in a multitude of jingling phrases, many of which are too hackneyed for the columns of a one-cent newspaper.

A manual of technical directions for the grinding, finishing, setting, testing, and computing of lenses, prepared by *Henry Orford*, has been issued under the title *Lens Work for Amateurs* (Macmillan, 80 cents). The directions are full and explicit, and are supplemented by two hundred and thirty-one cuts. The author disclaims any attempt to give an easy method for the manufacture of lenses, but he has aimed to furnish a serviceable guide to both young workmen and amateurs.

The Psychological Review has undertaken a series of Monograph Supplements, in which may be published longer dissertations than can be admitted to the Review. The first issued is *On Sensations from Pressure and Impact*, by *Harold Griffing*. The results obtained from the investigations herein described relate to discrimination between different intensities and durations of stimuli, between the same stimuli applied to different areas and different parts of the body, the difference in the discriminative powers of different individuals, etc.

In an article on *Evolution and Christianity*, reprinted from the Wooster Quarterly, Prof. *Horace N. Mateer* gives a popular statement of what evolution is, assenting to its validity, but affirming also the truth of all the important doctrines in the Bible. He says that the position of the Bible is strengthened by placing it upon a scientific foundation.

Four essays by as many writers, reprinted from The Engineering Magazine, have been issued as a pamphlet with the title *Architectural Education for America*. In the first of these Arthur Rotch tells what is the influence of the École des Beaux-Arts; Robert D. Andrews describes a practical training; the English method is set forth by R. W. Gibson; and Barr Ferree closes with An Outsider's View. The object of the pamphlet is to bring together the chief points of merit in the systems most familiar to the American architect, so as to throw some light on the question, How shall the American architect be trained professionally to reach the best results for architecture in his own country?

The first of the 1895 series of Ethical Addresses is *What we mean by Duty*, by *W. L. Sheldon* (S. Burns Weston, Philadelphia, yearly, $1; single number, 12 cents). After pointing out that popular conceptions of duty regard it as something stern and forbidding, the author shows that it should rather be regarded as the conformity of conduct to natural order.

In a pamphlet published by the Theosophical Society, Tacoma, Wash., *Fred G. Plummer* attempts to prove a *Change of the Earth's Axis*. His argument is clearly put

and shows a wide acquaintance with both ancient traditions and modern geological writings. (Price, 25 cents.)

A pamphlet entitled *A Few Facts about Turkey under the Sultan Abdul Hamid II*, by *An American Observer*, tells of important advances in the railroads, docks, finance, education, army, navy, and other affairs of that country. Several pages are devoted to showing that the Armenians are deceitful and conscienceless agitators. Testimony is given also to the effect that the attitude of the American missionaries toward the Armenians is not always judicious. (Printed by J. J. Little & Co., New York.)

S. Baring-Gould is at his best as a student of mystery, antiquities, traditions, folklore, and myth; and whatever we may find under his name we are sure that some of the results of his studies in these fields are interwoven in the matter. His stories, consequently, depart from the overworked models on which too much of the usual fiction of the day is drawn, and are always certain to afford something novel, fresh, and instructive. These words apply well to his *Noémi*, which is published by D. Appleton & Co, in their Town and Country Library. The story takes us back to Guienne of five hundred years ago, in what is now southern France. The region—near Domme—is terrorized over by Le Gros Guillem, a leader of the Free Companies, whose supposed daughter—a girl stolen from the Fénelons, and from whom the story is named—and her lover—who has a leading part in delivering the region from its oppressors—are the central objects of interest. The story, in its plot and general structure, reminds one of Lorna Doone, although the style and method of treatment are vastly different.

The text of Prof. *F. E. Rockwood's* edition of *Cicero's Cato Major*, or *De Senectute* (American Book Company), is substantially that of C. F. W. Müller (Leipsic), but a few variations have been made. The text is supplemented by a general introduction concerning Cicero's life and works; illustrative notes on the pages with the text; grammatical and textual notes, a list of variations from Müller's text, and indexes to the notes and of proper names. The introduction has been made somewhat full in order to present, in convenient form, besides the sketch of Cicero's life, a brief account of what he has accomplished in literature and philosophy. Altogether, this is a very satisfactory edition of one of the most charming essays ever written.

PUBLICATIONS RECEIVED.

Agricultural Experiment Stations. Reports and Bulletins. Colorado: Hemiptera of Colorado. Pp. 137.—Cornell: Recent Chrysanthemums. Pp. 28.—Feeding Fat to Cows. Pp. 12.—Delaware: Spray Calendar; San José Scale Insect in Delaware.—Illinois: Russian Thistle; Potatoes.—Michigan: Vegetable Novelties and Notions; Potatoes; Pests of Orchard and Garden; Small Fruit Notes; Native Plums; Russian Cherries; The Apple Orchard.—New York: Forcing Lettuce in Pots; Mushrooms as a Greenhouse Crop; Comparative Profits from Milk, Butter, Cream, and Cheese.—Oregon: Zoölogy. Pp. 11.—United States Department: Protection from Lightning. Pp. 25; Use of Metal Railroad Ties. Pp. 33; Weather and Crop Service. Pp. 15.—Wisconsin: Pasteurization of Milk and Cream for Direct Consumption. Pp. 48.

Bailey, L. H. The Horticultural Rule Book. Macmillan & Co. Pp. 392. 75 cents.

Beddard, Frank E. Zoögeography. Cambridge Natural Science Manuals. Pp. 246.

Biological Lectures. Delivered at Marine Biological Laboratory of Woods Holl, Summer Session, 1894. Ginn & Co. Pp. 287. $2.65.

Blatchford, Robert. Plain Exposition of Socialism. Commonwealth Publishing Company. Pp. 172. 10 cents.

Bulletins and Reports: Academy of Natural Sciences, Philadelphia. Pp. 211 to 290.—American Humane Association: Vivisection and Dissection in Schools.—Coast Survey: Magnetic Declination in Alaska.—Columbia College: The Protolenus Fauna; The Effusive and Dyke Rocks near St. Johns, N. B.; Crystalline Limestones, etc.; Glacial Lakes of Western New York; Recent Glacial Studies in Greenland; On a Granite Diorite from Westchester County, New York.—Geographical Club of Philadelphia: Bulletin No. 5.—Geographical Society (National): Beaches and Tidal Marshes of the Atlantic Coast.—Health Bulletins: Iowa, Tennessee, Wisconsin; Trinity Church Tenements (Sanitary Condition of).—Wagner Free Institute of Philadelphia: Transactions, Vol. III.—Zoölogical Society of Philadelphia: Twenty-third Annual Report.

Fitzgerald, Joseph. Pitfalls in English. Pp. 123.

Galton, Francis. Fingerprint Directories. Macmillan & Co. Pp. 200. $2.

Hittell, John S. The Spirit of Papacy. Pp. 314.

Macdougal, D. T. Experimental Plant Physiology. Henry Holt & Co. Pp. 83. Teachers, $1.

Meunier, Stanislas. La Géologie Comparée. Pp. 292. Germer, Baillière et Cie.

Menschutkin, N. Analytical Chemistry. Macmillan & Co. Pp. 512. $4.50.

Monroe, James P. The Educational Ideal. D. C. Heath & Co. Pp. 262. $1.

Nevin, William M. Lectures on English Literature. Intelligencer Printing Office, Lancaster, Pa. Pp. 485.

Preston, Thomas. The Theory of Light. Macmillan & Co. Pp. 503. $3.

Quinn, Rev. D. A. Stenotypy. Continental Printing Company, Providence, R. I. Pp. 53. $1.50.

Reagan, H. C. Handbook and Chart of Brush Arc Light System. Norman W. Henley & Co. Pp. 48. $1.

Reynolds, A. R. Report of the Department of Public Health of the City of Chicago. Pp. 268.

Ribot, Th. The Diseases of Personality. Open Court Publishing Company. Pp. 163. 75 cents.

Seidel, Heinrich. Der Lindenbaum. American Book Company. Pp. 71. 25 cents.—Die Monate. American Book Company. Pp. 72. 25 cents.

Shearman, Thomas G. Natural Taxation. G. P. Putnam's Sons. Pp. 239.

Smith, H. M. Notes on a Reconnaissance of the Fisheries of the Pacific Coast. Pp. 63.—A Statistical Report on the Fisheries of the Middle Atlantic States. Pp. 130. Government Printing Office, Washington, D. C.

Smithsonian Publications. Bureau of Ethnology: Chinook Texts. Pp. 278; The Siouan Tribes of the East. Pp. 100; Archæological Investigations in James and Potomac Valleys. Pp. 80.—National Museum: Directions for Collecting Plant Specimens, etc.; Directions for Collecting Rocks, etc.; Directions for Collecting Minerals, etc.; Scientific Results of Explorations by United States Fish Commission Steamer Albatross; Directions for Collecting and Preparing Fossils.

Stifter, Adalbert. Das Heid·dorf. American Book Company. Pp. 80. 25 cents.

Tracy, Roger S. Handbook of Sanitary Information. D. Appleton & Co. Pp. 114. 50 cents.

Van Rensselaer, Mrs. Schuyler. Should we Ask for the Suffrage? Pp. 57.

White, Horace. Coins Financial Fool. J. S. Ogilvie Publishing Company. Pp. 112.

POPULAR MISCELLANY.

A Child's Thoughts about Providence.—A very instructive account of the mental aspects of childhood is given by Miss Isabel Fry, in a book called Uninitiated, one of the purposes of which is to show that it takes much longer for children to learn the real drift and meaning of the habits and expressions and feelings of their grown-up friends and attendants than it does to master the language in which those feelings are conveyed. She thus pictures the process gone through by a child in conceiving the meaning of God's constant observation and care of his creatures: "I was thinking dreamily about heaven, and how wonderful it was that God could always see me. Could he see, for instance, and did he notice that I had a button off my boot, or did he overlook some things and only trouble himself about that which was actually either good or naughty? I did not know. And then nurse said that he was always taking care of me every minute. Didn't he ever leave me alone at all? I supposed not. But surely if he saw that I was sitting on this chair, and knew that nurse had made up her mind not to come in for, say, twenty minutes, he might leave me at any rate for a little while. But no; I hardly thought he would. Then I went on to try to imagine what would happen. Supposing, for any reason, he did leave me. I should probably fall down through some vast open space and die. No, not exactly die, for then God would have to decide whether I was to go to heaven or hell, and I should be once more in his keeping, and in that case I should be just sitting here in the night nursery again for all the world, as I was doing at this moment. I could not make up my mind what would happen, and I felt it would be almost worth while to try the experiment." But if she should ask God to leave off taking care of her she might go so fast that she would not be able to pray him to take her back. But she would pray him to let her go for just one single second, and then take care of her again. After a long struggle with herself and much trembling, she did so—and nothing happened. "Breathless and motionless as I sat with eyes staring and ears strained, I could perceive no change whatever in myself or in my surroundings. The sewing machine in the nursery still purred on; little Samuel still knelt in the picture on the wall opposite me, with the yellow light still fiercely streaming upon him, and the bluebottle who had been keeping up a continual "fizzle" was still fighting on the window pane. I set myself rigidly, and tried again to feel the sort of falling or collapse which I had imagined. Still I felt nothing, and I had at last to give up the effort, and believe that for some reason, which perhaps I was not quite old enough to understand, God would not let go of my still sobbing body."

Science in Finland.—Besides the National University at Helsingfors, which had nineteen hundred and twenty-nine students in 1894, with the number increasing regularly, Finland has several scientific and other learned societies. The Finnish Society of Sciences, founded in 1838, has published, besides its regular volumes of transactions, a series of works on the nature, ethnography, and statistics of the country. Among its later achievements is the foundation of a central meteorological institute, which is assisted by the Government. It has, besides, taken part in a number of international polar

expeditions, and has established a station at Sodankyla, in Lapland. Other societies are the Natural History Society (*Societus pro faunâ et florâ fennicâ*), founded 1821; the Society of Finnish Literature, the Finno-Ugrian Society, the Finland Historical Society, the Finnish Archæological Society, two geographical societies, a medical society, and a legal society. Among Finlanders distinguished in science and letters have been Lönnrot, grammarian and collector of the national literature; Ahlqvet, another able grammarian; Hallstrom, physicist; the illustrious astronomer Argeländer; the mathematicians Lindelof, Schulten, and Mittag-Löffler, the last editor of the international journal Acta Mathematica; the explorer Nordenskiöld, who removed to Sweden in 1857 to escape trouble on account of an address he had made at a students' festival; the botanist Nylander; the zoölogist Nordmann; and the surgeon Estlander. Swedish literature is also distinguished by several Finnish names of great writers; Finnish literature is very ancient, although it has only recently begun to receive special attention. The later poets and romancers have discussed in the fresh and spontaneous old poetry of the ancient folklore a nearly inexhaustible mine of rich images and striking epics. Finland has further produced eminent artists in various lines. The full story of the achievements of this too little known country of the far north is told in the book La Finlande au XIX siècle, which the writers and artists of the country have combined to make up, published at Helsingfors, in French, in 1894.

Report on Opium.—The opium commission appointed many months ago by the British Government was charged with the investigation of three questions—whether opium, when taken in moderation, is injurious; whether Indian opinion is opposed to its use; and whether prohibition is a practicable policy. The commission has published its report, and declares that by a vote of eight to one it answers all the three questions in the negative. The commission finds that an immense number of doctors in India believe opium to be less injurious than alcohol. Witnesses drawn from every grade and class testified that it is an excellent remedy against malarial fever; that it can be and is consumed in moderation all through life; and that its effect upon the constitution in health is practically *nil*. Among natives the belief in the value of the drug is nearly universal. The practice of opium-eating pervades every class, is considered allowable by every class, and the people are opposed to prohibition. The commission, therefore, though they believe some improvement in the restrictive laws may be possible, refuse to suggest any, and advise substantially that the present system be left alone.

Steel Buildings.—A steel building, as the words are now used by builders, is a structure supported by a steel frame, which frame should carry all the other materials used in the construction. If the frame is so arranged that it will always hold the building securely in the position and condition in which it was first erected, the other materials used in construction will be required chiefly to perform some other office than that of giving strength and support. As considered by Mr. C. T. Purdy, in his paper on the subject, the most important difference between the old brick and stone buildings and the new steel ones is in the construction of their exterior walls. Brick and stone in the older forms of construction were used first of all to make the building strong. In steel buildings this use of masonry has nearly disappeared. It is used instead only to inclose the structure from the outside air and elements, to protect the frame from fire, and to afford opportunity for architectural effects. Thick walls are useless with these frames, and no matter how high the building is, the exterior walls do not need to be heavier at the bottom than at the top. Openings may be made in them in almost any way or of any size. In some respects the larger they are the better, and the wall in any story may be removed without injury to that above or below. This is a great change. The steel frame has worked a great difference in the concentration of loads. Walls tend to diffuse and spread the loads which they carry. They act as beam and column at the same time, and it is not always easy to tell what part of the foundation supports a given load in the upper part of the building. With the column construction this indefinite feature

becomes definite, for all the loads are sure to be concentrated at the column centers that carry them. Kindred to this change is the large independence of partition walls which the steel construction makes possible. Another radical change, and the most conspicuous to the eye that steel has introduced, is in the height of large buildings. Steel buildings—their construction admitting of unlimited bracing—may be carried to any height, the only restrictions being those imposed by the character of the foundations, the land, and economical considerations. The steel construction admits a vast increase of window space, the masonry walls which had to be built for strength being no longer required, and their place may be taken by glass.

The Weather and Mental Action.—Who has not felt the difference between a depressing and an exhilarating day? Sydney Smith wrote: "Very high and very low temperatures establish all human sympathy and relations. It is impossible to feel affection above seventy-eight degrees or below twenty degrees." Dr. Farr and Dr. Stark almost lead us to think morality is registered on the thermometer, so surely does it measure certain kinds of criminality. On suicides the effects of the weather are well known. Nearly all vocations are affected by weather. Men of science are often as much subject to weather as seamen. Some writers must have the weather fit the mood, character, or scene. If one will read poetry attentively, he will be surprised to find how many weather marks are scattered through it. Diverse weather states may be one cause of so much diversity and even disagreement in thought processes usually regarded as scientific. Many experienced teachers think there should be modifications of school work and discipline to correspond with the weather. The head of a factory employing three thousand workmen has said, "We reckon that a disagreeable day yields about ten per cent less work than a delightful day, and we thus have to count this as a factor in our profit and loss account." These are some of the ideas put forth in a preliminary statement by J. S. Lemon, who proposes to publish more at length upon the subject. "Laboratory investigation of the subject," he says, "meets at the outset the difficulty of distinguishing results of weather changes from similar states otherwise caused. This difficulty is no greater than in many other topics of research, and we believe will not invalidate our methods and results."

Characteristics of Recent Geological Study.—If one were asked, says Sir Archibald Geikie, to specify the feature which above all others has marked the progress of geology in Britain during the past five and twenty years, he would reply, the enlarged attention given to the study of the rocks, or petrography; and this study has been revolutionized by the introduction of the microscope as an adjunct to research. The rocks of the country have become a foremost object of study. In stratigraphical geology a much closer attention than ever before has been given to the investigation of the most ancient accessible parts of the earth's crust. The fundamental platform on which the fossiliferous rocks repose has been searched for and has been detected in several places where it was not before supposed to exist. We know more clearly than before the general outlines of two or more great geological periods anterior to the earliest relics of animal life. Among the applications of paleontology to the stratigraphical side of geology the most important in recent times has been the recognition of life zones among the stratified formations and the adoption of these as a clew to the interpretation of the sequence of strata, and even under some risk of error of tectonic structure. In the department of geotectonics one of the most interesting features has been the increased attention bestowed upon the nature and results of the great movements that have affected the crust of the earth. Another distinguishing characteristic of the period has been the increased interest taken in the history of the earth's surface or its superficial topography as contrasted with the almost exclusive attention given by the older geologists to the story of the rocks. The views respecting the possible age of the earth have undergone several modifications by geologists and physicists alternately, with accepted periods ranging from four hundred millions down to ten millions of years. The latest phase of them is that put forward by

Prof. Perry from the physical side, that, on the assumption that the earth is not homogeneous, as Lord Kelvin supposed, but possesses a much higher conductive and thermal capacity in its interior than in its crust, its age may be enormously greater than previous calculations have allowed.

Modoc Songs.—During his talks with Modoc Indians, Mr. Albert S. Gatchett has been able to record from dictation a number of curious songs which these people highly appreciate, and frequently sing while at work and while sitting idly in their lodges. Only a few of them are lugubrious, but the majority are merry utterances of a mind free from care. There are erotic songs, dance songs, satiric and mythologic songs, all delivered in a way that is half spoken and half sung. Some, however, have attractive and elaborate melodies, which, if well arranged for the piano or string instruments, would doubtless produce a sensation in cultured communities. A specimen is given of a song which is introduced as sung or spoken by a prairie owl, which has the faculty of turning its head around and then turning it instantaneously to the normal position; while, when it draws its body up, it appears almost ball-shaped, and when traveling over the prairie seems like a light-colored ball rolling over the ground. The man singing the song is supposed, after throwing off his garments and limbs, to appear also as a head only, and rolls on for many miles, when he may be seen partaking of food inside of his subterranean lodge. He has a dog who faithfully tries to gather up his discarded appendages, and take them first to his master and then home. With this is coupled an idyl of a young man carrying his sister on his back to her bridegroom, and leaving her close to a pine tree. A cradle song describes the habits of the robin, which is seen earlier than other birds flying toward the cedar to pick at the bark in search of ants; the mothers tell their babes that robin redbreast sings this song to its young, and sometimes also to its grandmother. A third song has a satirical application to another town than that of the singers.

Uses of Science Teaching.—Dr. Michael Foster defines two uses for the teaching of science in schools. The first he calls the "awakening" use, and the second the more distinctly "educational" training use. The minds of the young being differently constituted, one mind is especially awakened by one branch of knowledge, another by another. Physiology serves as awakening knowledge to a large enough number to make it desirable to teach it. For this purpose it should be taught "as a new independent subject, not demanding any previous knowledge. It should be presented as a wholly new field, into which the mind may wander at will without any restrictions as to being qualified for entrance. It also follows that the teaching must be of a most elementary kind; that as much of chemistry or physics as is necessary for the comprehension of the physiological matters should be taught with the physiology, and, as it were, a part of it, the pupil being led into chemistry and physics by his interest in physiology, and not being compelled to learn the one, for which he or she perhaps does not, at present at least, care, before beginning the other. The instruction given, however elementary, should consist in part of demonstrations and practical exercises." In this way, Dr. Foster would have physiology very widely taught, but not made a compulsory study. As a distinctly educational study, as a training for the mind, he regards it as unsuitable for schools.

American Life Zones.—Six life zones of animals and plants are described by C. Hart Merriam, in his Ornithological and Mammalogical Report to the Department of Agriculture, as having been defined in this country north of the tropical zone. They may be grouped under the two heads of northern or boreal, and southern or austral. The *Arctic* or *Arctic Alpine* zone is above the limit of tree growth, is the home of the polar bear, arctic fox, reindeer, etc., and has no agricultural importance. The *Hudsonian* zone comprises the northern or higher parts of the great transcontinental forest, and is likewise of no agricultural importance. The woodland caribou and the moose are probably its most striking animals. The *Canadian* zone, comprising the southern or lower part of the great transcontinental coniferous forest, is the first zone, coming from the north, of any agricultural consequence. It has its charac-

teristic animals, and in it white potatoes, turnips, beets, the Oldberg apple, and the more hardy cereals may be cultivated with moderate success. In the *Transition* zone, the outlying boreal and austral elements overlap; the forests and the fauna are mixed, and northern and southern trees and animals grow and live side by side. In this zone we enter the true agricultural part of our country, and the hardier crop plants attain their highest perfection. In the *Carolinian* zone trees adapted to a warmer climate, like the sassafras and tulip tree, first make their appearance, and the semi-hardy fruits, the sweet potato, tobacco, and the hardier grapes reach their best conditions. In the *Austro-riparian* zone, the long-leaved pine, magnolia, and live oak are common on the uplands, and the bald cypress and cane in the swamps; the animals and birds are characteristic. This is the zone of the cotton plant, sugar cane, rice, pecan, and peanut, and of tender fruits. Still farther south is the *Tropical* region, which in the United States is restricted to southern Florida and extreme southeast Texas, along the Rio Grande and the Gulf coast. The Division of Ornithology and Mammalogy is engaged in tracing the courses of these regions across the continent, and in the preparation of large scale maps on which their boundaries are shown in different colors.

Antillean Elevations and Depressions.—A study by Charles Torres Simpson, on the distribution of the land and fresh-water mollusks of the West Indian region, touches upon the evidence they afford with regard to past changes of land and sea. The author finds that a considerable proportion of the land snail fauna of the Greater Antilles seems to be ancient and to have developed on the islands where it is now found. There appears to be good evidence of a general elevation of that region after most of the more important groups of snails had come into existence, at which time the larger islands were united and a land connection existed with Central America by way of Jamaica, and a considerable exchange of species went on between the two regions. At some time during this elevation there was probably a landway from Cuba across the Bahama plateau to the Floridian area, over which certain groups of Antillean mollusks crossed. This period was followed by one of general subsidence, during which Jamaica was first isolated, then Cuba, and afterward Hayti and Porto Rico. The connection between the Antilles and the mainland was broken, and the Bahama region, if it had been previously elevated above the sea, was submerged; the subsidence continuing until only the summits of the mountains of the Greater Antillean islands remained above water. Then followed another period of elevation, which has lasted, no doubt, until the present time, and the large areas of limestone uncovered in the Greater Antilles furnished an admirable field for the development of the groups of land snails that survived on the summits of the islands. The Bahamas have appeared above the surface of the sea, either by elevation or growth, and have been peopled by faunas drifted from Cuba and Hayti, and a number of land and fresh-water species have been colonized in south Florida. The Lesser Antilles have been peopled for the most part from South America.

Smoking in Mashonaland.—The luxuries indulged in by the Mashonas appear, according to W. A. Eckenberg, of the railroad survey, "to be confined to tobacco—not usually smoked, but taken as snuff—and beer manufactured from the seed of the millet. Drunkenness is an uncommon vice, except among certain of the chiefs. In the coast districts hemp is smoked in a hookah pipe of simple construction. A long, narrow gourd forms the body of the pipe. Halfway down it a hole is made of a convenient size for applying the lips. The gourd is filled with water halfway to the level of the hole. Through the closed top is inserted a small hollow reed, reaching nearly to the bottom of the water, and protruding well beyond the upper end of the gourd. To the upper end of the reed is fixed the clay or stone bowl of the pipe, and this is of very small size, capable of holding only a sufficient quantity of hemp for a few whiffs. The smoker, holding the gourd upright to prevent the escape of the water, applies his lips to the hole, and draws the smoke to his lungs, through the water, by two or three vigorous inhalations. The result is made known to the whole neighborhood by a violent and apparently purposely exaggerated coughing and spluttering; the

louder the cough, the keener appears to be the enjoyment of the smoker and his companions. The pipe is passed round, until the whole of the smokers are engaged in violent contortions, accompanied by an almost terrifying coughing."

Aboriginal Art in Copper.—Very interesting specimens of objects made of wood and covered with copper have been found among the relics of the American aborigines. Several have been described by Prof. F. W. Putnam and by Warren K. Moorehead, both of whom have found them in Ohio. Other objects have been found of copper sheathed with silver, gold, or meteoric iron. It is shown clearly that the American aborigines in the Mississippi Valley and in South America had the art of cold-hammering copper, of beating it so as to overlie and fit upon a warped or curved surface, and of turning the edges under. Yet more elaborate work is exhibited in two specimens sent to the National Museum by Lieutenant G. T. Emmons, United States Navy, of figures of hummingbirds in wood, well carved and painted red, each wing and tail of which is overlaid with a covering of sheet copper, pressed down to fit and turned under at the margins so as to be held fast. The surfaces are adorned with the conventional wing and eye signs of the Haidas. Especial attention is invited by Mr. Otis T. Mason to the carving on the copper. The furrows and ridges are all cut with steel tools. The work is regarded by Mr. Mason as "above and beyond the ability of the aboriginal metallurgists of the Mississippi Valley."

Korean Hats.—The hats of the Koreans are described by Mr. H. S. Saunderson as shaped somewhat like inverted flower-pots, with broad, straight brims, measuring nearly two feet across; while the crowns are about six inches high and three inches in diameter at the top. "The shape is undoubtedly due to the way the hair is dressed. These hats are made of horsehair or very finely split bamboo, beautifully plaited, and are varnished, as a protection against the weather. They are invariably stained black, except for half mourning, when they are string-color (that is, of natural hemp). They are usually fitted with bands which are tied under the chin, but in the case of high officials these bands are replaced by a long string of beads joined at each end to the hat. This hat does not fit upon the head itself, but rests upon a tightly fitting skullcap, held in place by strings tied round the head. The natives are very careful of their hats, for they are expensive, and when it rains they always protect them with little coverings of the oiled paper for which the country is famous, and of which they make their waterproof coats, tobacco pouches, and fans. The officials, when on court duty, wear even more extraordinary hats than these, but their shapes are so fantastic that it is perfectly impossible to describe them. In the winter, fur and wadded head-dresses are worn under the hats. . . . The official servants wear hats made of black or brown camel's-hair felt with small round crowns and large flat brims; while those worn by the soldiers are much the same in shape as the gentry's, but are made of black felt, have much smaller brims, and are bound with red." The most curious hats are those of the mourners, shaped like enormous toadstools, and so large as to hide the face. They are made of plaited bamboo strips, and are not colored. The women wear nothing on their heads, except in winter, when they put on curiously shaped fur caps, open at the crown and adorned in front and behind with red silk tassels.

Uses of Wire.—Wire is shown in Mr. J. Bucknall Smith's book on its manufacture and its uses, to be employed for a great variety of purposes, and these having a very extended range. It is used for the delicate hair springs of watches, and in the form of large cables supports suspension bridges. It is also used in the manufacture of pins, needles, and fish-hooks; it has been applied in coils to the construction of heavy ordnance, and it forms the periphery of a huge fly wheel recently constructed in Germany. Wire ropes are valuable in supplying the means of haulage in mines; by their help materials are transported in the air over a rough country; they are used for the traction of tram cars, and of barges along canals; and, being stronger, lighter, more durable, and cheaper, they advantageously replace hempen ropes for towing, moving, hoisting, and other purposes. Filigree work is formed of fine silver and

silver-gilt wire; the finest wires are inserted to serve as the hairs within the eyepieces of the telescopes of surveying and astronomical instruments; and wire is largely used in fencing and netting. Steel wire forms the frames of spectacles, and has replaced whalebone in the ribwork of umbrellas. It is also employed for the strings of pianos and other musical instruments, and has found a more recent application in the spokes of cycle wheels. Copper wire forms the coils round the magnets of dynamo machines for generating electricity, and it transmits the electric current to a distance after its production, for the purposes of illumination. It, moreover, furnishes the vehicle for the transmission of messages by the telegraph and telephone; and when inserted in submarine cables it forms a connecting link between distant parts of the world, and permits the firing of under-water mines in security by an electric battery at a distance. The great diversity of uses to which wire is applied is due to the increased tensional strength possessed by metals when drawn into wire, which is owing to the great tensional resistance acquired by the outer skin; to the flexibility, combined with strength, possessed by wire cables; to the facility with which wire can be drawn out to a variety of gauges; and to the extreme fineness that can be attained with certain metals in the process of wire drawing.

Cereals in Japan.—The most important cereal crops of Japan, according to a report recently issued, are rice, barley, and wheat. Rice is cultivated in nearly all the provinces, and, either as flour or whole grain, boiled with rice, is a common food. It is whitened like pearl barley, steeped five or six hours in water, and then boiled. One of the most common articles of food is *miso*, which is prepared by pounding together boiled soy beans, salt, and the *koji* or yeast, prepared from common barley. Barley is also used for brewing beer and making confectionery, and as food for horses and cattle. Its straw, bleached and plaited, is used in summer hats. Wheat is also generally cultivated, and is principally used for preparing soy, vermicelli, and confectionery, and its straw for thatching roofs, etc. Some barley and wheat is exported to foreign countries, barley chiefly to Hong Kong and Vladivostock, and wheat, in flour, to Russia and Korea, and as grain to Hong Kong and England. The manufacture of straw plaits and other goods from bleached barley stalks is assuming large proportions. Although Japanese straw is not so good as that of Italy, it is better than that of China. Articles of straw, especially toys, have been made for many centuries, but recently, stimulated by the demand for exportation, the manufacture of plaits has increased rapidly.

Chitral.—Chitral, where the British recently conducted a successful military campaign for the relief of their post, is described by Captain Younghusband as "a mountainous country, which, if you could get a bird's-eye view of it, you would see to be composed partly of gigantic snowy peaks, partly of barren rocky mountains, and, in a very small degree, of cultivated land. The valleys are narrow and confined, the main ones in their inhabited portions running from five thousand to eight thousand feet above sea level. It is only in them that any cultivation at all is found, and even there it is not carried on very extensively. But what there is is generally very good, and Chitral is a country noted for its fruit." All the ordinary cereals are grown, though in the higher part of the valleys it is only possible to produce barley and buckwheat. The whole food production is small, and barely suffices for the people of the country. The climate varies, of course, according to the height of the valley. The population of Chitral is probably about seventy thousand or eighty thousand. The people are all Mohammedans, but not of a very strict or fanatical type. In the lower part of the Chitral Valley, where they touch on the Pathans, so noted for their fanaticism, they have become to a certain extent tainted by it; but in the upper valleys the people are very quiet, and do not seem to trouble themselves much about religious observances. On the whole, the Chitralis may be described as a peaceable race, who can fight well enough when they are roused to action, but who really prefer to keep quiet and be left alone to enjoy life in peace. They are very fond of sport, and delight in polo, which they play in an offhand, "go-as-you-please" way. The ruler of the country is designated the Mehtar, and has absolute power up to a cer-

tain point, beyond which he is hedged in by custom; and nearly all the affairs of state are transacted at the audience hall, where every man has his say and perfect freedom. The state is situated between Cashmere and the Hindu Kush Mountains.

Making the House Healthful.—The relation of the house to the prevention and treatment of disease is set forth by Dr. G. V. Poore, in The Practitioner, as a matter of prime importance. The danger of the communication of infectious disease to the other inmates of the house in which it appears has long been recognized, and the list of diseases communicable in this way is extending; yet sufficient account of this danger is seldom taken in planning and constructing the dwelling. The main object to be kept in view in building a house, and especially in building a house for invalids, is the supply of fresh air. Too much care can not be taken to insure that all the channels of internal communication—hall, passages, staircases—have independent ventilation of their own. Unless there be means of getting these internal channels blown out by through draughts, the house can not be wholesome; and in the event of any air-borne contagion getting a footing in the house, the liability to spread is enormously increased. These internal channels must have light also. If the house be of several stories, the ventilation of the staircase has an importance that bears a direct proportion to the height of the house. The shafts for elevators require independent ventilation as much as the staircases. One of the chief defects in the construction of city houses is the absence of provision for effective ventilation; so that the internal channels of communication, instead of serving for the supply of fresh air, merely facilitate exchange of foul air. This defect of construction is dangerous in proportion to the size of the building and the number of persons it contains. The suggestion has been made to place the secondary staircase (in invalid homes) between the wards and the sanitary offices, so that the staircase well forms a cut-off, with cross-ventilation between the ward on one side and the various sinks, closets, and baths on the other side. The point which requires more attention than any other in building a house is the aspect. This is too often neglected. A house should receive its maximum amount of sun. The best aspect for a house is generally conceded to be that which allows its chief rooms to look to the southeast. In this way the morning sun is enjoyed, and the rooms do not get the glare of the afternoon sun. It may be advisable to build a house in the form of a veritable sun-trap. The sanitary advantage of a large area for a house is very great indeed. In hospitals we now recognize that infinitely the most important element of the "cubic space per bed" is the floor area, and that a deficient floor space is not to be compensated for by giving great height to the wards. The same reasoning is applicable to a house.

Irrigation of the Nile Valley.—In projecting the irrigation works for the Nile Valley Engineer Scott-Moncrieff first undertook to restore the barrage built by Mohammed Ali—two stone bridges of seventy-one and sixty-one arches respectively thrown across the Rosetta and Damietta branches where they bifurcate. The arches were intended to be fitted up with gates, by lowering which the water would be dammed up and turned into three great brick irrigation canals. The idea of these works was excellent, but the execution was feeble, and they had so far failed to accomplish their purpose. They were again taken in hand and completed in 1890, since when the barrage has given no trouble. The three great canals carry off all the river supply from above it, so that practically now the low Nile is emptied every season at the barrage, and no water escapes to the sea. Attention was next directed to providing for the storage of the surplus waters of the upper Nile. The first scheme was to build a great dam at Philæ, to be one hundred and fifteen feet high, eighty-five feet at the base, and a mile and a quarter long, pierced by sluices large enough to allow the whole Nile at highest flood to rush through. The lake formed would have been one hundred and twenty miles long. The execution of this plan would have drowned the island of Philæ with its splendid Ptolemaic temples built on the sites of older buildings that disappeared centuries ago; and the civilized world protested against the vandalism, though

it were perpetrated in the name of public utility. Even the French for once agreed with the English about what should be done in Egypt. The plan was changed. The majestic structure of the dam will be cut down thirty-seven feet, so as to be only eighty-eight feet high, and Philæ will stand in a lake, but will not be drowned.

Patinas of Japanese Bronzes.—Describing the patinas of Japanese bronzes, Mr. W. Gowland, late of the Imperial Mint, says that in many bronzes the beautiful color is due to a "stain" or colored film of infinitesimal thinness. In others, the surface of the metal is altered to a considerable depth, and in these only we have true patinas. Frequently both a stain and a patina are produced by similar treatment, but the operations required for the latter are of a more prolonged character than for the former, and are accompanied by special manipulations in addition to the application of what are called pickling solutions. For the production of patinas of the richest and darkest shades of brown by Japanese methods, it is essential that lead should form one of the constituents of the bronze, and that zinc should either be absent altogether or be present only in small proportions. On the other hand, stains of any color can be given to metal of any composition, and even to unalloyed copper. The substances used in the operations are copper sulphate, basic acetates of copper (verdigris), iron sulphate, sulphur in fine powder, alum, vinegar prepared from unripe plums, and a decoction of the roots or entire plant of *Calamagrestis Hakonensis* (natural order *Graminæ*), potassium nitrate, and sodium chloride. The most important of these reagents are the first five. The processes for producing a patina by the use of the various solutions of these substances are somewhat complicated and difficult, and the intermediate operations, on which its production depends more than on the exact composition of the solution, are variously modified in different foundries.

The Peril of Color-Blindness.—Renewed attention has been called by Surgeon W. M. Beaumont, of the Bath (England) Eye Infirmary, to the importance of perfect color vision for railway servants, which is unquestioned in the minds of ophthalmic surgeons, however other doctors and railway directors may be disposed to ignore it. Some questions asked by one of the doubting doctors, whether, since attention has been turned to the subject, any accident has been brought home to defect in color vision, or other facts demonstrating the theory have been brought out in usual practical sailing and railway life, are answered by reference to several illustrative incidents that have been gathered. Of these are the wreck of the steamer City of Austin, on the Florida coast, with a color-blind pilot; the collision of the Corbet Castle and the T. H. Ramieu, due to the color-blindness or short-sightedness of the chief officer; the collision of the Lumberman and the Isaac Bell, near Norfolk, Va., the Lumberman's master being color-blind, and consequently taking the wrong course with his vessel; and the narrow escape of the steamer Neera from a collision through the color-blindness of its officer. In another instance the color-blindness of a railway fireman and the imminent danger of collision thereby were experimentally determined in the ordinary working of the train. Even where the color-blind engineer believes he can distinguish between the signals, and appears to do so, he does it, not by the color, but by the difference in intensity. This is a very uncertain and indefinite factor, and is liable to variations according to the weather, the condition of the engineer, and other causes not so well known, and can not be safely depended upon.

Farming on the Yang-tse Kiang.—The country in China along the Yang-tse River from Shanghai to Hankow, and for a hundred miles on either side of the river, is, in general, a rich alluvial plain, traversed by ranges of hills having an east and west trend. The tops of the hills give the best tea, and where the ground is stony fir and oil trees are planted, for oil, resin, timber, and firewood. On lands of intermediate height—or where the land is not suitable for rice—cotton, wheat, corn, buckwheat, sweet potatoes, and kitchen vegetables are grown in great profusion. Dairy farming is unknown, and milk is looked upon with disgust. The native buffalo is the domestic animal employed in cultivating rice. Three crops can gener-

ally be secured in a year. A little indigo is grown for domestic use, and almost takes care of itself. In many respects the bamboo takes the place of metals, although iron, copper, and brass are well known, and have been from very early times. The young shoots make an excellent vegetable, and paper and twine of great strength are produced from the fiber. The fields are cultivated like gardens, well hoed and clear of weeds. All the tools with cutting edges are of native manufacture, and steeled and tempered on the edge.

NOTES.

In the excavation of the ancient Roman city at Silchester, England, twelve rectangular inclosures or buildings have been found, all of the same type, and containing furnaces, obviously of an industrial character, and of various sizes. The circular furnaces correspond exactly with the dyeing furnace at Pompeii, and are supposed to have been used for a like purpose. The supposition is corroborated by the large number of wells discovered. A number of other furnaces with a straight flue are supposed to have been intended for drying. Several rooms are traceable which, it is presumed, were intended for the storage of goods and materials, and open spaces with no remains of flues which may have been used for bleaching grounds. A number of querns for hand-grinding the madder-roots used for dyeing purposes have been discovered.

A man shot through the brain, says Mr. Victor Horsley, dies, not through failure of the heart's action, but through the want of breath occasioned by the explosive effect of the bullet passing through the wet brain substance, and consequent injury to the base of the brain. The heart goes on beating, but respiration stops; indeed, the heart is stimulated, not depressed, when a bullet enters the brain; and the proper treatment of a man thus shot is the same as that resorted to in the case of drowned people—one should try to set up artificial respiration.

The investigation of the effect of metals on the growth of bacteria has been continued by Dr. Meade Bolton. His process was to inoculate a tube of melted jelly with particular microbes, and pour the contents out on a sterilized glass plate, after which bits of the metal under examination were laid on the jelly while it was still soft. If the metal has an inhibitory action on the microbes, then a clear zone is left around it after the colonies have developed in the other parts of the jelly. The width of this zone, Dr. Bolton found, varied very considerably with different organisms, as well as with different metals. Throughout the investigation it was found that those metals that are resistant toward chemical reagents in general failed to produce an effect on the microbes; while those metals which are readily attacked by chemical reagents all exhibited a marked inhibitory action upon the growth of bacteria. This result is probably due to a solution of the metal taking place in the medium.

Provision is made in the Missouri Botanic Garden for the furtherance of advanced research in botany and cognate sciences, and facilities are freely given to professors of botany and other persons wishing and competent to perform such work. The garden is rich in native and exotic species of plants, and horticulturists' varieties under cultivation; the herbarium includes nearly two hundred and fifty thousand species, fairly representative of the vegetable life of Europe and the United States, with specimens from other regions, and is supplemented by a large collection of woods; and the library is representative of the present condition of the science in its various departments, and contains besides nearly five hundred botanical volumes prepared before the period of Linnæus. Botanists wishing to pursue their studies here are invited to communicate on the subject with Prof. William Trelease, director, St. Louis.

The rapid decrease in the population of Ireland—from 8,300,000 to 4,600,000 in fifty years—is ascribed by Dr. Grimshaw, registrar general, to three causes: the frequent failure of the potato crop; the emigration stimulated by the high wages in America and the low wages at home; and the lack of manufacturing industries, the result of which is that when the crops fail the people become destitute and have to leave the country. Notwithstanding the decrease in the population, the registrar general believes that the country has gained in wealth.

Prof. Simon Newcomb has been elected by the French Academy of Sciences an associate academician as successor to the late Prof. Helmholtz.

In addition to the general courses of instruction of the Marine Biological Laboratory at Woods Holl, Mass., special lectures will be given on Embryology, by C. O. Whitman; Botanical Museum Development, by J. M. McFarlane; Matter and Energy, by A. E. Dolbear; and evening lectures will be delivered by specialists on biological subjects of general interest. Forty private laboratories are provided for investigators. The course of invertebrate anatomy will embrace simply a study of typical marine invertebrates, through lectures, laboratory work, and excursions; that in vertebrate anatomy has been arranged for those who desire a thorough

study of the vertebrate body. The work in botany will be restricted to the study of the structure and development of types of the various orders of the cryptogamous plants Applications should be addressed to William A. Setchell, 2 Hillhouse Avenue, New Haven, Conn.

DR. E. B. TYLOR suggests the use of correspondence in culture as a means of tracing lines of connection and intercourse between ancient and remote peoples. The Egyptian conception of the judgment of the dead by weighing in a spiritual balance may be traced in a series of variants that seem to draw lines of intercourse through the Vedic and Zoroastrian religions. The associated doctrine of the Bridge of the Dead, which separates the good, who pass over, from the dead, who fall into the abyss, appears first in the ancient Persian religion, reaching to the extremities of Asia and Europe.

THE subscription of $250,000 required by the law incorporating the New York Botanic Garden as a condition precedent to the city's furnishing $500,000 more and a site, has been completed, and the Garden may now be regarded as a near certainty. Its friends purpose to go on with their efforts and secure an increase of the subscriptions to $500,000. The site chosen, comprising 250 acres, is in Bronx Park, on both sides of the Bronx River.

THE difference between European (continental) and our own methods of criminal procedure was strikingly illustrated in a trial for murder by poisoning which recently took place in Antwerp. The presiding justice freely expressed the opinion that the evidence was convincing, and questioned the prisoner as if he had been a prosecuting lawyer; and the prisoner, who expected this, had to prepare herself for such treatment. She was herself the principal witness. The jury was presumed to take the judge's questioning for what it was worth as it would have taken them from a prosecuting counsel, and not as carrying any authority, as whatever the judge might say would do with us. The prisoner had her advantages under this method, for she could be her own witness and counsel, and explain the circumstances herself. No prejudice appears to have existed in the minds of any except that which was raised by the evidence.

THE Report of the Interstate Commerce Commission shows that the percentage of increase of railway mileage in 1894 was less than for any preceding year for which reports have been made to the commission. No better showing is anticipated for 1895. Sixteen roads were abandoned. The gain in the use of train brakes and automatic couplers was largely in excess of the increase of equipment during the year, but can not be considered as showing a marked tendency toward compliance with the law; for 74·80 per cent of the total equipment is still without train brakes and 72·77 per cent without automatic couplers. All must, by law, be supplied before January, 1898. The number of men employed was smaller than in any year since 1890, the largest decrease being in trackmen.

THE man or woman, says Dr. B. Ward Richardson, who trains himself in the best bodily health makes the best of life. Bodily welfare is important, not for itself only, but because the health of the mind so largely depends on the health of the body. A good engine outlives many of its masters because they attend to it more carefully than they attend to their own bodies. The usual relations of the age of maturity to length of life, indicating a ratio of one to five, suggest that a man taking twenty-one years to mature should live one hundred and five years. The fact that such life is exceptionally attained shows its possibility; and it is owing to errors that it is not more widely attained in the human species.

OBITUARY NOTES.

THOMAS HENRY HUXLEY died at Eastbourne, England, on June 29th. A severe attack of influenza early in the spring had been followed by bronchitis and other disorders. He several times rallied, but was finally obliged to succumb. A sketch of his career, by Ernst Haeckel, and a portrait, were published in an early volume of this magazine. Prof. Huxley had recently completed the revision of his essays for an edition that has appeared in nine volumes. His last magazine article was on Mr. Balfour's Attack on Agnosticism. It appeared in the Nineteenth Century for March, and was to be followed by a second paper which his illness prevented him from completing.

Prof. WILLIAM C. WILLIAMSON, well known as a biologist and paleontologist, died at Clapham, England, on June 23d, in his seventy-ninth year. When Owens College was founded in 1851 he was made its Professor of Biology and Geology, his researches having already won him an election as a F. R. S. Later this professorship was divided, and for many years he had held the chair of botany. He was the first to announce the existence in some of the deeper seas of what is now known as the foraminiferous ooze. He also made important researches upon the teeth and scales of fishes, and upon the fossil plants of the coal measures. He received the Royal Medal of the Royal Society, and the Wollaston gold medal of the Geological Society. The University of Edinburgh conferred upon him the degree of LL. D. He was elected by the Royal Society of Sweden to the foreign membership left vacant by the death of Asa Gray.